AMERICAN GALVANISED IRON ROOFING AND CLADDING

FROM THE 1870's TO 1920's

Andrew Benjamin Hall

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Robert L. Schuyler

Robert Schuyler, Associate Professor, American Civilization, Advisor

Henry H Glassie

Henry Glassie, Professor, Folklore and Folklife, Reader

David G De Long

~~David~~ G. Delong, Graduate Group Chairman

Thanks to my freinds

Jim Moskin and Javier Ibanez

who between them inducted me into the computer age.

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PREFACE

The dates chosen for the period of study for this thesis may appear to be arbitrary as may the restriction of its subject matter to cladding and roofing materials made of galvanised iron which ignores the multitude of other uses to which this form of building material has been put. There are however reasons for restricting the field of this study in the above manner, these having to do with my own close ties to the use of galvanised iron in South Africa, the period in which that country was dependant upon foreign supplies of sheet metal, and the uses to which it was put in the country.

A demand for galvanised iron arose in South Africa as a result of the many major mineral discoveries made in the northern part of the country in the late Ninteenth Century. The first such find was the Kimberley Diamond Rush of 1871 1./ which was followed by several gold rushes in the 1870's and 80's culminating with the establishment of Johannesburg in 1886. The towns and cities which arose in this period made much use of galvanised iron, but in such a way that the metal was only used in its simplest least ornamental form. The reasons for this will be discussed in the body of this work.

Galvanised iron continued to be used in profusion long after the rushes of the last century and indeed continues to be one of the most popular building materials on the sub-continent. Initially the bulk of galvanised sheets would have been imported from Britain, but research has shown that a fair volume also came from the United States. 2./ The growth of local industries during and after the First World War led to the creation of iron foundries to exploit local resources, and culminated in the establishment of the state owned "Iron and Steel Corporation" (ISCOR/YSKOR) in 1927. 3./ At this point dependance on foreign rolling mills declined as ISCOR entered the sheet metal market, and most galvanised iron from the early 1930's on bears the local brandmark.

The above history is essentially what has determined the parameters of this study, and it is hoped that the result will be a better understanding of the types of American galvanised sheet metal products suitable for use in the developing nations of the chosen period.

INTRODUCTION

This thesis is intended to be a history of the development of essentially American galvanised iron over the period from the 1870's to the 1920's and will study the way in which galvanised iron developed and was used in its various forms as a building material during this period. This is not intended to be a study of the technology behind the manufacture of the material and developments in this area will only be briefly discussed where they are essential to the understanding of other properties of the medium. (Articles which go into greater detail on the technological and manufacturing aspects of galvanised iron are listed in the bibliography.)

Although this galvanised iron and is still used in building for flashing, ventilation, ornamentation and structural members, as has already been mentioned, the subject of this thesis has been restricted to uses of galvanised iron as a cladding and roofing material. Galvanised iron was by no means the only sheet metal material used for purposes of roofing and cladding in this period, and many other metals, for example: zinc; tin; copper; lead; various other forms of metal coated

iron and black iron (that is iron with no protective coating) were common. Many of these other sheet metals, in particular black iron, were used in the same manner as galvanised iron and aspects of this study are as appropriate to their use as they are to galvanised iron.

Though generally known as galvanised iron, in the 1890's with the discovery of alloys which were stronger and more resistant to corrosion than less refined forms of iron, steel became as much used for galvanising as was iron. 1./ This caused some manufacturers to refer to their products as "steel", but most continued to use term "iron". Whether the terminology used did relate to the specific compounds used in manufacture or whether this trend was due to the fact that the public understood and used terms such as "galvanised iron" and "corrugated iron" without regard to the processes and materials used in their manufacture is not known, and, in order to avoid further confusion the term "iron" has in this study been used to refer to both forms of galvanised material.

Another source of some confusion when discussing galvanised iron, and one which will be discussed in greater detail in a chapter on corrugated iron, has to do with the means wereby the thickness of materials was

and is measured. Various sets of gauges exist and it is usually impossible to tell which of them was used when recommendations were made for the use of certain thicknesses of sheet in a certain situation. Figure 30 is a weight and gauge chart for the three gauges which appear to have been most commonly used during this period.

The fifty odd years discussed in this thesis were, as will emerge, the period during which the American galvanised iron industry came into its own as American iron and steel output boomed and overtook its European competitors. The era was is one not only of expansion on the local market, but one which saw the development of several new products and the emergence of American galvanised iron rolling mill products onto international markets.

A BRIEF HISTORY OF GALVANISED IRON IN THE UNITED STATES

By the 1870's galvanised iron was a well established and popular building material, its development having taken place in the 1830's and 40's. The origins of galvanised iron and the popularity of its use as a building material are connected to advances in both industrial and building techniques essentially in the early 19th Century.

The development of galvanised iron, a material used in a variety of areas other than architecture, was as a result of development in three areas of the iron industry. Of these the first was the rolling mill, early versions of which were already in existence in the 1720's, 1./ and which, as it developed over the following century, was able to roll out flat sheets of metal in increasingly large sizes and with increasing efficiency. The second development was the discovery of the galvanising process by a Frencman, Sorel, in 1837. 2./ This process is one wereby iron is coated with a thin layer of zinc in order to protect it from the elements, in particular moisture which causes corrosion, which, up to this point, had been the major drawback in

the use of sheet iron as a building material. Although other processes of coating iron with protective layers (usually of lead or tin) developed at around this same period none of them were at the same as durable or cheap to produce as was galvanised iron. A third process which was important in the development of galvanised iron, and one which will be discussed in more detail in a chapter dealing specifically with corrugated iron, was the discovery that sheet metals, if crimped to form ridges or corrugations in their surface, possess a great deal more strength than if they are simply used as flat sheets.

In the area of building techniques two developments took place which determined that galvanised iron would become one of the most efficient and effective forms of shelter in the 19th Century. The first and with regard to galvanised iron, probably more important of these techniques, concerns the development of the balloon frame in the 1830's. 3./ This frame, already light and easy to erect, was made even more effcient when combined with the lightweight and inherent strength of galvanised iron. The second technique, also one concerning a framing type with which galvanised iron was frequently used, was the development of various forms of metal frame during the 19th Century.

The combination of the above factors led to the development of a material which had as its advantages its light weight, durability, low cost and quick, relatively unskilled erection requirements. In having these attributes, which were being constantly improved on throughout the period under discussion, galvanised iron was unrivalled and fast became a universal building medium, incorporated into the vernacular building techniques and styles of many cultures.

Iron roofing was fairly common in America before the invention of galvanised iron, the first record of its use in the new world dating to records from Quebec as early as 1799. 6./ Iron sheets were used by Benjamin Latrobe (with Thomas Jefferson's encouragement) on the roofs of many early U.S. government buildings, 7./ and William Strickland and Andrew Jackson Downing were among other early American promotors of iron roofing materials. 8./ Galvanised iron itself first came to the United States as a British export at in the 1840's and much of its early worldwide popularity has been attributed to its extensive use on the California Goldfields in the 1850's. Most of this early galvanised iron was imported from Britain even though the first U.S. patent was taken out in 1838. 9./

The early American sheet metal industry was slow to develop due to competition from exports and even though there were sheet rolling mills on the Schuylkill and Brandywine Rivers in the early 1800's there was very little expansion of the industry until the Civil War. 10./ Local production of galvanised iron hence also remained small up until the 1860's when the combined efects of the Civil War and the introduction of the protective "Morell Tariff" in 1861 stimulated development. 11./ From the 1860's onwards local production of galvanised iron products became widespread and American products enjoyed an increasingly large proportion of the local market. 12./ Further protective tariffs introduced in the 1890's and early this century further protected the industry and by 1913 an imported galvanised sheet of any gauge was subject to a 27 % tariff. 13./

These protections and the resultant growth of the American galvanised iron industry led to the development of some uniquely American galvanised iron building materials and the importation of galvanised iron products to all parts of the world. These and other factors relating to the further history of the American

galvanised iron industry will be discussed in the body of this thesis.

THE MERITS AND DEMERITS OF GALVANISED IRON

Throughout its history galvanised iron has been seen to have had various merits and demerits and, depending upon the type of building on which it is to be used and what its function on that building is to be, these have been of greater or lesser influence upon those using it as a building material. In the late Nineteenth and early Twentieth Centuries much debate centered around the various factors which determined that galvanised iron would be either a good or bad material when used in a certain context. While much was done to promote its use, it was at the same time competing with other newer materials many of which it was claimed could fulfill the functions of galvanised iron without the disadvantages inherent in the use of that material.

In general sheet metal, and in particular galvanised iron, rose to prominence as a building medium due to the following factors: its strength; lightweight; impermiability to water; invulnerabilty to insects and most types of rot; and its fireproof qualities. 1./ No less important was also the fact that erection of galvanised iron buildings required the minimum of skill 2./ and often little or no foundation. 3./ These

qualities were as prominent from the 1870's on as they had been in the preceding thirty years and many of them were enhanced or added to by developments in the period being studied. In an article in 1879, Carpentry and Building discusses the merits of sheet iron in general, the arguement being prompted by negative public perceptions of iron as a building material following several disastrous fires in cast iron buildings. 4./ This article adds to the list of advantages the fact that iron provides a greater degree of flexibility when designing and is also more durable than many other materials. The durability of galvanised iron seems to have been a matter of some debate in its early years, but with the development of better galvanising processes and the fact that a certain amount of time had elapsed in which the material had had the opportunity of proving its durability, galvanised iron became accepted and promoted as more than just a material suited to temporary structures and one which could in fact last many years if properly maintained. 5./

In the United States the fire resistant properties of galvanised iron appear to have been regarded as its principle advantage over other materials and this seems to have been the most important factor in its promotion on the domestic market from the 1870's onwards. This

emphasis was probably due not only to the fact that iron was the most fire proof building material cheaply available in this period, but because, being used primarily as a roofing material, its principle competitor was the traditional wooden shingle which has as its main disadvantage its high flamablity. Journals of the sheet metal trade were at this period filled with articles on the advantages of galvanised iron as a fire proof material, 6./ and sheet metal contractors are time and again urged to emphasis this property when seeking contracts. Many even conducted public tests, lighting fires under panels of various types of roofing material and exhibiting the results. 7./ Similar tests illustrating the lightning proof qualities of metal roofs were common in the 1920's. 8./

Much was made of the fact that metal clad buildings could do much to prevent the spread of fires from property to property in a way that frequently destroyed entire streets or towns. Metal cladding not only prevented internal fires from spreading to the exterior of buildings, but also tended to hold together longer than other materials and, in the case of roofs in particular, collapsed as a single sheet, in this way having a blanketing effect on the fire below. 9./ From

the turn of the century onwards there were articles lauding the fact that many city fire codes promoted or required the use of sheet metal and that fire chiefs and insurance companies endorsed its use. 10./ In rural areas, far from fire control services, the use of sheet metal was also seen as advantageous and in 1914 was in fact endorsed by the Department of Agriculture for use on farm buildings. 11./

From the turn of the century the fire resistant qualities of sheet metal were given an added boost with the invention and growing popularity of the automobile, and galvanised iron was regarded as the ideal material for the construction of fireproof suburban garages. 12./ It was also regarded as a useful material in other areas of fire risk, for example explosives magazines, 13./ and in Japan was prescribed for use alongside railway lines where the traditional thatch was a constant fire hazard. 14./

As regards the disadvantages of galvanised iron, the material is not one which is beyond reproach, and its problems are legion, even when it is used in seemingly appropriate contexts. Corrosion was and still is the principal drawback to its use and, though mainly experienced as a result of moisture, was in this period

increasingly being noticed to be a result of an acidic industrial environment which destroyed the galvanised layer exposing the iron beneath it to moisture which then caused rust. As early as 1883 it was noted that galvanised iron was probably not suited to most industrial uses, especially foundries where metal roofs were said to be particularly vulnerable unless painted at regular intervals. Some researchers go so far as to claim that the reason that in Britain in particular galvanised iron developed as essentially an export commodity was quite simply because it was unsuited to use in industrial environments. 15./ A 1913 study in Pittsburgh, analysing weight loss of samples exposed for several years in different environments, revealed that in that city roofs had to be repainted and replaced two or three times as often as in less smoky environments. 16./ Some research appears to have been done to make sheets more resistant to corrosion. Most of this is related to the development of various iron alloys which were found to better resist corrosion than iron in its purer forms. 17./ Once corrosion had set in little could be done to prevent its spreading and patching remained the only solution. 18./ The 1890's did however see the development of various cements and sealants suitable for use on galvanised materials and hence patching was more effective than it would have been previously. 19./ In

1913 Metal Worker, Plumber and Steam Fitter even reported an attempt to create a galvanised surface to which rubber sealants where likely to better adhere. 20./ This attempt does not seem to have been practical for building materials since it involved an electroplating process which was not possible on the scale required for metal sheeting.

Paint remained and still is the best means of protecting sheet metal, including galvanised iron, from the elements and throughout the period of this study there was much debate around which types of paint were best suited to the purpose. In the 1870's very little was known about the effects of paints on iron or which and why certain paints seemed to be better at protecting metals. Carpentry and Building, in an article in 1879, comments that lead paints have been found by the English to be best, but that no testing has been done to determine why. 21./ The same article claims that the lead should be used in an oil rather than spirit base since spirits tend to have a corrosive effect. In addition to lead it would appear that iron oxide and various forms of tar paint were also used to paint galvanised iron, but were not as effective. 22./ Coal tar paints were found to be too acidic, but pitch and asphalt seem to have enjoyed sucecess effective. 23./

Coal tar could however be neutralised by the addition of lime in which case it was less damaging to the metal beneath it. 24./ Early articles on painting galvanised surfaces often prescribe a coating of boiled linseed oil before painting. 25./

The first testing of paints for iron roofs seems to have been done in the mid-1880's and tested coal tar, iron oxide and lead paints on the basis of degree of deterioration after the same period of exposure in the same environment. 26./ Red lead emerged from these tests as the most durable paint. From the turn of the century there is evidence of a much greater concern over the types of paint suitable for use on iron surfaces and much more detailed research and testing occurred. Debate centered around the properties of both paint vehicles and pigments, and the correct proportions required of each to provide the most durable coating. By the 1920's research was being done on the different qualities required for a paint to cleave to a metal surface, as opposed to those required for it to protect the metal from outside influences, and separate prime and surface coats began to become the recommended means of protection. 28./

The above discussion of paint protection could be

applied to any metal surface and, over and above the considerations applicable to most building metals, galvinised iron, because of its zinc surface, required specialised treatment if paint was to stick to it for any length of time. In general before any paint works effectively on a zinc surface that surface should be allowed to corrode for a time until it looses its initial shine. This process should however not proceed too far since corrosion of the protective zinc layer should not be allowed to reach advanced stages. 29./

The other essential disadvantage of galvanised iron as a building material is its bad insulating properties and especially the tendency for heat to build up inside structures built of the material. This problem, generally only considered applicable in domestic housing, was as important in industry where there was much heat build up from from furnaces and other equipment. Heat build up seems to have only become an issue in the late 1890's when the first suggestions for placing insulating materials on the underside of the roof and setting vents in the roof appear. 30./ These two methods appear to have been the most common means of preventing heat build up and, in certain cases heat lose, but there were other suggestions one of the more unusual of which included an idea for running a

continuous stream of water over a roof on hot days. 31./ It does however appear to have been a fairly standard practice to have sprinkler systems at factories. These sprayed water onto roofs at regular intervals. A report in Metal Worker, Plumber and Steam Fitter in 1911 shows that such spraying was not very effective, only reducing internal temperatures by 1.7 - 2.8 oF, depending upon the size of the building; the days high; the humidity and the wind speed. 32./ Insulating was not always the best solution to heat problems since in humid climates condensation occurred on the underside of the roof and made the insulation damp ultimately causing the roof to rust. 33./ Insulating materials were however found to have advantages other than those for which they were initially intended, and were effective in combatting another of the disadvantages of galvanised iron, that is the fact that rain tends to be noisy on iron roofs. 34./ A further advantage was that insulation could be used to protect the sheeting from acidic gases generated inside the building. To this end its was recommended that it be used to line the interiors of stables, where fumes from manure had been found to be detrimental to the galvanised surfaces on the interior of the buildings. 35./

Of all the drawbacks to the use of galvanised iron the

one concerning its aesthetic qualities was probably the most difficult to combat. From the outset most seem to have agreed that it was not a material suited to domestic use, 36./ and this view persisted into the 1870's and 1880's. 37./ There was little galvanised iron producers could do to combat aesthetic antagonism towards their products and even attempts to produce less obviously galvanised iron products, for example imitation stone and brick face met with scorn from those with Ruskinian views of how building materials should be applied. 38./ The attitude of the sheet metal trade seems in general to have accepted their products aesthetic inferiority and with it the fact this would probably only affect their sales in areas where trends were set. Stone and brick face, as well as tiles and shingles, continued to be sold regardless of aethetic ideals. From the turn of the century the trade appears to have placed its emphasis on the other more advantageous qualities of its products, only from time to time lamenting the fact that building codes often restricted the erection of galvanised iron buildings for aesthetic reasons. 39./

Galvanised iron was at this period no longer the unique material it had been in the 1840's, and many new strong, and/or lightweight materials were being developed.

Initially its competitors were, other than shingles, the other common metal roofing materials, that is various types of tin plate and copper, both of which galvanised iron could economically compete with being of much lower price. (In the 1870's tin appears to have been cheaper than galvanised iron, 40./ but by the 1880's was less expensive. 41./) Another competitor was the plain ungalvanised black iron sheet which could be used for almost all the same purposes as galvanised iron, but was far more prone to corrosion and hence required more regular maintenance in the form of painting and patching. Composition roofing materials, made of various mixtures of tar, paper and gravel, were developed in the 1870's, 42./ and were much cheaper than, though not as durable as galvanised iron. 43./ Zinc was another popular roofing material at the turn of the century, but was both heavier, weaker and more more expensive than galvanised iron, though less prone to corrosion. 44./ Asbestos roofing was developed in 1917, 45./, but does not seem to have been much of a threat to the galvanised iron market and much the same may be said of the various forms of cement tile roofing which began appearing in the early 1900's. 46./ The only real threat to galvanised iron was one that was only felt in much later years and which, tough on the market in the 1910's, does not appear to have had an early impact. This material

was aluminium on which Metal worker, Plumber and Steam Fitter in 1915 make the comment that it was becoming popular in places like the Congo where its light weight enabled it to be carried by porters, something not as practical with galvanised iron. 47./

All in all and despite many disadvantages to its use galvanised iron does seem to have occupied a unique place in the building materials market of this period, most of its success being due to its basic properties of strength lightness and durability. This combination of properties, and galvanised iron's very competitive cost, determined that its position in the market would go unchallenged for many years to come.

GALVANISED IRON PRODUCTION, TRADE AND EXPORT

(INCLUDING AN ASSESMENT OF ITS CONTRIBUTION IN DEVELOPING REGIONS)

Since the use of galvanised iron was in the case of most products aimed a market in developing areas it is important to examine not only the domestic American iron market and the prices paid for galvanised iron at various times during the period under study. One should also look at how producers in the United States regarded their export trade, and especially their competition with large producers, in particular Great Britain, with whom they competed for the market in developing countries, most importantly those of Latin America.

As has already been noted the first galvanised iron materials came to the United States from Britain in the 1840's, and this trade was greatly stimulated by the California gold discovery of 1848. 1./ Gilbert Herbert estimates that the popularity of galvanised iron and the resultant growth of this trade determined that by the 1860's half of Britain's production of the material was being exported to the United States. 2./ It was only really the stimulation of the American Civil War and the

application of tariff restrictions in the 1860,s that made the United States galvanised iron producers a force to be reckoned with on both the domestic and international markets.

It is difficult to determine what prices of locally produced galvanised iron were in the 1870's ,80's and early 90's due to the fact that prices of various products are not as well differentiated as they were by the late 1890's. There was however a remarkable reduction in the price of galvanised iron from the 1870's to the turn of the century, this presumably being as a result of improved production techniques. Wholesale figures from the New York market for January 1878 indicate that U.S. produced sheets cost 8 cents per pound for 21-24 gauge sheets increasing in cost to 8.5 cents for 25-26 gauge and 9.5 cents for 28 gauge. 3./ By 1898 prices for 28 gauge galvanised sheets were as low as 3.12 cents per pound. 4./ From the period after 1900 the price of galvainsed iron fluctuated around levels slightly above 3.12, a price only again seen in 1904. 5./ 1912 at one point saw prices dip to an apparently all time low of 2.8 cents per pound for 28 gauge sheets 6./ but prices recovered to once again hover around the 3.5 cents level until mid-1915 when the impact of the war in Europe and the demands it produced on iron

production began to be felt. In 1916 the price for 28 gauge sheets reached 6 cents per pound and went on to a high of 10 cents in July 1917 when it leveled out. 7./ The price remained above the 6 cent mark until early 1919, and through most of 1920 traded between the 7 and 9 cent marks, but by the end of that year was back in the mid-5 cent range. 8./

Before 1905 figures for U.S. iron and steel production were not separated and it is hence impossible to get a clear idea of how the sheet iron market operated, it forming only a small proportion of the total sheet metal output. 9./ (For example: in 1905 72,156 tons of sheet iron were produced as opposed to 3,640,074 tons of steel. 10./) Similarly statistics for production of galvanised iron do not appear to have been separately listed in this period and the only figures available are for total production of iron sheets, that is any rolled iron product thinner than 13 gauge. 11./ Not knowning what percentage of these sheets were galvanised and similarly what proportion was intended for use in the building trade an analysis of these figures would seem futile especially in light of the fact that fluctuations in production figures do not seem to correspond in any ways to changes in the price of galvanised sheets and hence must have been due to factors other than those

influential in the galvanised iron market.

Just as the debate around the trade tariff issue is important in understanding the development of the American galvanised iron industry in the late nineteenth century, so is the influence of the First World War crucial to an understanding of its development in the early twentieth century. The war had two somewhat diverse effects, initially stimulating production and, as has been noted prices, through cutting off European producers from their export markets and leaving a gap in the market which American producers were only too keen to fill. In the second phase of the war, that is after America's entry, government demands and restrictions on iron and steel products limited production and areas of use of galvanised iron and badly damaged its market as a building material by causing competing products to be used in its place. All three major trade journals, that is Metal Worker, Plumber and Steam Fitter, Sheet Metal Worker and Iron Age have numerous articles in the years 1918 and 1919 complaining that the trade was still suffering from the effects of high prices during the war. 12./

American interest in export markets for galvanised iron had its origins long before the outbreak of war in 1914,

but American producers, being latecomers found it difficult to compete with the well established British trade. In the 1890's Britian's galvanised iron trade was by no means restricted to its colonies and, although the three major recipients of this trade were Australia, India and South Africa, in that order, fourth and fifth place were occupied Argentina and Chile respectively. 13./ Total British exports in 1894 amounted to about 170,000 tons of which Argentina took 18,000 tons and Chile in the region of 10,000. 14./ British imports were by not limited to only these two South American countries and this strong competition in Latin America, which was the United State's closest and therefore natural market for galvanised iron products, was hard to break.

From the turn of the century there is evidence of growing American interest in export markets in Latin America and the types of products needed in that region. This is evidenced by an increasing number of articles in trade journals aimed at creating an interest in foreign markets, particularly those of South America, and by factors such as the availability of American trade catalogues in Spanish as well as English. 15./ One of the major factors mitigating against purchase of American products by foreigners was higher freight costs

than those from Britain. Even though U.S. producers, for example Milliken Brothers, claimed that their products were cost competitive with those from Britain, Germany and France, 16./ freight charges seem to have neutralised any advantage American producers might have had. For example, in a 1907 discussion of the use of galvanised iron in Peru, Capentry and Building commented that all galvanised iron in the country came from Britain since American importers paid ten percent more on freight which amount was sufficient to put them out of the market. 17./ In a similar article on El Salvador it was commented that freight from Britain was $3 per ton less than rates from New York. 18./

At the outbreak of war in 1914 American producers appear to have immediately realised the implications for potential American exporters and, as early as in September, 1914 Metal Worker, Plumber and Steam Fitter was giving hints on how to deal with South American merchants who it was expected would be cut off from European producers. 19./ Americans were quickly able to take over large sections of the British held market, as for example in Argentina, where by the end of 1915 American entrepreneurs were already providing a quarter of the country's needs. 20./ Further evidence of the degree to which American sheet metal was able to take

over from British interests and even hold the market after America's own entry in to the war is evidenced by an August 1918 article on roofing in the West Indies. In examining the state of the trade with the British Colony of Jamaica, which almost certainly would have been an exclusive preserve of British producers before the war, it is noted that U.S. trade for the preceding twelve months amounted to $49,132 as opposed to British takings of only $2,896. 21./ In a post-war article on Bolivia the same journal comments that in that country Americans had taken over nearly 100% of the galvanised iron trade, 22./ and despite the cutbacks and restrictions on production in 1917 and '18 American producers do seem to have been able to out produce Britain in those years and thus hold onto export markets which they had established in the early years of the war. In 1922, in an article on the Japanese galvanised iron trade, Iron Age comments that American sheets were first introduced during the war and have since held a significant proportion of the market despite strong competition from British products, an indication that the exclusivity of the British market had not only been challenged in the Western hemisphere but in other areas as well. 23./

In examining the possibilities for entering foreign markets American journals showed a great awareness of

the type of uses to which galvanised iron building materials were suited and how they could be used in what were essentially developing countries. An examination of these articles provides an interesting insight into the needs of such countries and how galvanised iron was able to meet those needs in manner often very different from the way it was used in more developed regions. In better developed countries such as Argentina needs for agricultural buildings were promoted, 24./ and it was thought that there might even be a market for more sophisticated products such as sheet metal shingles. 25./

In other, less sophisticated places, it was recognised that there was a market for products like corrugated iron and plain flat sheets for use in domestic housing. In Bolivia for example it was noted that both galvanised iron roofing and siding had become popular because in the highlands of the country where wood was scarce, its strength and lightweight determined that wooden frames could be much lighter than those required to support, in particular, the traditional tile roof. 26./ Similarly in discussing Ecuador it was commented that many people used galvanised iron, not as a replacement for their traditional split cane and clay houses, but as an outer siding over these materials in order to lend outer walls

added strength and durability. 27./ In El Salvador there was interest in the fact that in the 1890's a form of galvanised iron building had evolved which was also an adaptation of traditional building techniques. This developed as a response to the danger from earthquakes and the danger posed by the heavy tradional adobe and Spanish tile in such situations. The form of building which evolved was one which looked much like traditional buildings, having balloon frame mounted corrugated iron walls which were plastered on the outside to give a smooth finish. In the event of an earthquake such structures were said to be much less prone to collapse and created less danger from falling masonry. 28./ This was not the only manner in which galvanised iron was used in El Salvador and several large public buildings were were built using the material in a more conventional manner, but also to counter act the affects of earthquakes. 29./

American interest in unique and novel uses for galvanised iron products was by no means restricted to Latin America and there was often comment on its use in Africa where it was found to be popular among the first waves of European settlers to populate newly opened up areas. 30./ It was also noted with interest that where galvanised iron was in short supply or unaffordable

flattened out cans or barrels were used as substitutes, 31./ a practice which persists to this day.

Of particular interest to Carpentry and Building seems to have been the possibilities for the use of prefabricated or portable sheet metal buildings in both Latin America and Africa and betweem the years 1903 and 1909 there are articles concerning their use in Panama, Honduras, Columbia, Mozambique and South Africa, 32./ Most of these deal with the advantages of such buildings in areas where wood or other building materials were not readily available or in frontier situations where buildings were urgently required. In this regard the rapidly developing American West was also a fruitful market, and one in which the aesthetic considerations were possibly not as important in domestic architecture as they would have been in more developed parts of the country. From the 1860's on there was a large market for prefabricated buildings in the American West, 32./ but most of these buildings would not however have been of sheet metal. Sheet metal does for various reasons (these are addressed in the chapter on the merits and demerits of galvanised iron) seem to have become popular as a building material in small recently established towns in the United States after the turn of the century. The promotional magazine Sheet Steel Service, in existence

from the years 1924 to 1926, focused on towns in which sheet metal had been used extensively for both roofing and other building purposes. Most of the buildings in these towns appear to have had their origins in the 1890's and the early years of this century, and the towns in which they are situated are essentially in the Mid- and South-West. 33./ In this way the American galvanised iron trade is demonstrated to have contributed not only to the development of foreign countries but also to the development of new regions of this country.

CORRUGATED IRON

Corrugated iron was and is the best known and most generally used form of galvanised iron, and was the product which, in the 1840's, made galvanised iron the popular building material it still is today. Invented at around the same time, corrugation and galvinisation from the earliest periods of production have been synonymous with one another. The process of corrugating sheet metals in order to give them added strength was, according to Charles Peterson, first used around 1830, and its invention is attributed to various British entrepreneurs. 1./ Early corrugations were pressed one at a time, a labourious process which made the product expensive, or were cast in corrugated moulds. 2./ Herbert describes the early rolling process as being done while the sheets were red hot, 3./ and claims that it was only with the invention of the cold rolling process, at the Phoenix Iron Works in Glasgow in 1844, that the production of corrugated iron became really feasible since the new process enabled it to be produced in large quantities at relatively low cost. 4./ The patenting, in Britain in 1845, 5./ of the galvanised corrugated iron sheet completed the development of what was by the 1870's one of the most common building

materials in the world.

Corrugated iron, though in this country most generally associated with industrial, agricultural and warehouse type buildings, was and is in other parts of the world used on both residential and commercial structures, this despite the fact that it probably comes under more criticism on grounds of aesthetics than does any other galvanised iron product. In residential and commercial uses corrugated iron is usually a roofing material, but can also be used as siding, in much the same way as it is used in factories, though in such cases the interior is generally lined with some form of wooden sheathing.

Apart from the general atributes of galvanised iron corrugated iron has the additional advantage of the strength lent it by its corrugations. In the period under discussion various sizes of corrugation were available each type having a different application. The larger a corrugation the stronger it is (that is when working with sheets of the same gauge) and sheets of greater strength required less framing and were hence cheaper. 7./ This did not however make large corrugation sheets popular and, although sheets with five inch corrugations were available the standard size corrugation was half that. 8./ The reason put forward

for this is that "smaller corrugations give a more pleasing appearance" 9./, and were hence more popular on aesthetic grounds. 10./ The two and a half inch corrugation must have been the smallest size practical before too much strength was lost, and although sheets in smaller gauges (for example: one and a half inch; one and a quarter inch; three quarter inch and five eighths of an inch 11./) were available they were generally intended only for decorative uses, usually as ceilings. 12./ Three inch corrugations were also available from some rolling mills, but did not come in the same variety of lengths as the standard two and a half inch corrugation. The American Rolling Mill Company produced stock length sheets at one foot intervals from five to ten feet, but would only supply three inch sheets at even lengths. 13./ (See Figure 1 for profiles of various sheets.)

Depths of corrugations also appear to have varied slightly, and the 1905 Milliken Brothers' catalogue warns those placing orders for sheets to be used on existing corrugated iron buildings to ensure that they specified depths before placing orders. 14./ The most common depths for two and a half inch corrugation sheets were either a half inch or five eighths of an inch, and Neubecker in his 1927 work on sheet metal claims

that these depths were considered standard on sheets with corrugations of two and a half to one and a half inches, while five inch corrugations were usually an inch deep. 15./ (Figures 28 and 29)

As has already been mentioned most factories produced corrugted iron in a variety of lengths, usually no shorter than five feet and not exceeding twelve feet, 16./ a length which seems to have been unusually long and which, though available, was not considered a standard size. 17./ Widths were also fairly standard and seem to have differed essentially according to the use to which a sheet was to be put. Generally sheets were expected to cover a twenty four inch wide space, but were always wider, width depending upon the degree of overlap used in construction. Standard two and a half inch corrugated sheets would generally have come in either twenty seven and a half inch or twenty six inch widths while other sheets came in slightly different size, dependant upon the lengths of their corrugations, 18./ the idea being that sheets, when laid, could either overlap at full or half corrugation intervals. Sheet widths were quoted in measurements after corrugating, and a standard, two and a half inch corrugation, twenty six inch wide, sheet would have had ten corrugations. 19./

Corrugated iron also came in a variety of gauges use of a particular gauge depending upon the strength and durability required in construction. It is very difficult to ascertain which gauges were most commonly used since, in addition to the fact that various standard gauges existed, some manufacturers quoted gauges before galvanising while others quoted them once that process was completed. This situation is further complicated by the fact that not all galvanised layers were of the same thickness and sheets with thicker galvanising, but of the same gauge as others would not have been as strong. Nevertheless it seems that most the most popular gauges were in the range from 20 to 28, while sheets were manufactured in gauges anything from 13 to 30. 20./

The great advantage that corrugated iron has over other building materials, including its fellow galvanised iron products, is that it requires the least skill to erect. There are nevertheless certain standard techniques used in corrugated iron building, and these, as they were developed and applied in the period being studied, are what will be discussed in the remainder of this chapter.

A little has already been said about methods of lapping

corrugated iron and the two different types of overalp for which sheets were produced. In laying corrugated iron roofing it is important that where sheets lap the top sheet end in a downward curve. (Figure 83 diagrams C and D) This allows water to shed out of the join instead of into it as would be the case if the last corrugation were to turn upward. 21./ For this reason corrugated iron sheets intended for use on roofing have both edges turning the same way, this enables them to overlap in such a way that there is always a down turn in the edge of the top sheet of a join. 22./ By contrast siding sheets, which do not require the same watertight qualities as roofing materials, have a corrugation ending in a down curve on one side and an up curve on the other. (Figure 8 diagrams A and B) In this way sheets intended for use as siding have a half corrugation less than those used for roofing, a factor which could lead to considerable savings in expenditure on larger buildings. This also determines why, in certain applications, that is roofing, a one and half corrugation lap is used while in others, that is siding, there is only a single corrugation lap. Hence also the differences in the widths of sheets. Lapping at the ends of sheets depended once again upon their use, for siding it was recommended that they be lapped only three inches, 23./ while up to six inches was recommended for

roofing. 24./

Quite logically corrugated iron roofing should be laid with its side laps facing out of the wind, that is laying starts at that side of the roof furthest from the direction from which the strongest winds are likely to come. 25./ As to how sheets were attached to framing that depended upon the type of framing material used on the building. In the case of wooden frames sheets were attached using nails placed at regular intervals, usually in the top of every other corrugation along the top and bottom edges of sheets and, depending upon the length of sheet, across the middle too. It was recommended that a roof placed over rafters should be of at least 26 gauge and that sheets should be rivetted together along side edges at intervals of six inches. 26./ Purlins would obviously be spaced at intervals corresponding to places of attachment. One of the advantages of this building material was the fact that such framing was only required at such infrequent intervals because the strength of the corrugated iron contributed to the strenth of the structure. Neubaker recommended that purlins be differently spaced depending upon the gauge of material used. His recommendation for a standard corrugation sheet is that no more than a seven foot span be used for 16 to 18 gauge; five foot

for 20 to 22 gauge; four foot for 24 gauge and two foot for 28 gauge. 27./ Corrugated iron roofing could also be applied over sheathing board, or an existing wooden roof, in which case thinner gauges of material could be used since it was not required to lend strength to the structure. (For relative strengths of sheets see chart at bottom of Figure 29.)

When corrugated iron was laid over a metal frame the intervals at which sheets were attached would have been the same as above, but the method of attachment differed in that nails could not be used. Various systems of cleating developed whereby sheets were attached to framing members by means of some form of strap or clip which was either rivetted or bolted to the corrugated iron sheet. (Figures 12, 42 and 43) Some of these could also be used on wooden frames. (Figure 2) The essential problem encountered in attaching corrugated iron to metal framing was that of expansion and contraction of the metal sheets, something which was not as great a problem with a wooden frame because wood allowed nails to move sufficiently to avoid stretching of nail holes. 28./ Cleats on steel frames had to allow for expansion and contraction in such a way that holes in the sheet did not become enlarged, nor by the same token should the movement of roofing sheets have allowed cleats to slip

off rafters. Much debate surrounded the best choice of cleat, but in most cases it was agreed that a cleat of the type shown in Figure 42 was most desirable, this despite the fact that it required the most labour to attach. 29./ Cleats such as those shown in Figure 12 (except type 1, which is much like the the example shown in Figure 42) were considered to have have too little grip on rafters and, apart from type 4, allowed insufficient room for expansion. 30./

Corrugated iron roofing and siding was by no means restricted to simple straight sheet and, although these were the types of sheet in general use, other more specialsied forms did exist. Curved corrugated sheets had been available since the earliest days of production and could be made to order in the particular shape desired. 31./ Another form of specialised corrugated iron was a sheet which instead of being lapped was connected by means of a standing seam. (Figure 14) Another sheet, which must have been similar in appearance to the one discussed above, was introduced in the 1870's and had a higher corrugation down each side, the intention of this being to better deflect water where sheets joined. 32./ Other, more significant developments, included various methods of combining sheets into flashings and cornices in such a way as to

eliminate joins at these points. 33./ One such type, an invention of the 1920's, was a ridge sheet (developed by the Milwaukee Corrugating Company) which combined the ridge roll into the sheet in such a way that no flashing was required along the ridge of the roof. (Figure 20) 34./ Many such developments were not restricted to corrugated iron and were as applicable to it as they were the other forms of roofing discussed in subsequent chapters of this dissertation.

More than any other form of galvanised iron corrugated iron embodies the advantages of its use as a building material into a light and flexible medium suited to a variety of very different uses all requiring a minimum of skill to successfully apply. Gilbert Herbert's statement that

> "Corrugated iron resulted in a system of construction, a quick and easy means of enclosure that was relevant to all buildings, both large and small." 35./

is just as applicable to the material as it was used at the turn of the century as it is to the manner in which it was used earlier in its development. It was a material which continued to be used in profusion all over the globe and one which would still is a universal building medium.

V-CRIMP ROOFING

Of all the galvanised iron materials discussed in this thesis V-Crimp is perhaps the one about which the least is known. It is a form of roofing material in many ways closely related to corrugated iron, but in other ways more like a standing seam roof. Much like corrugated iron in that it gains its strength from "V" shaped corrugations placed along each side of the sheet and sometimes also down the middle, in appearance it more closely resembles a standing seam type of application, and may have been derived from a desire to imitate that type of roofing without the same degree of skill being required for application.

Gilbert Herbert, in his comments on the early British corrugated iron industry, remarks on the production by 1850 of a sheet of galvanised iron which was fluted at both ends. This may have been an early V-Crimp, or simply a form of prefabricated seam, Herbert does not give a more detailed description. 1./ It cannot be ascertained exactly when V-Crimp roofing first came to the United States, but the American Rolling Mill Company (ARMCO) catalogue for 1921 comments that it is the oldest type of iron roofing available. 2./ Avertising

in the 1890's also mentions V-Crimp as "old style", perhaps some indication of the length of time it had been on the market. (Figure 44) It is however doubtful that V-Crimp was indeed the oldest iron roofing product available, it being almost a certainty that corrugated iron predates it.

General articles on roofing in trade journals from the period being studied rarely mention V-Crimp roofing and there are similarly few articles specifically devoted to the material. This does not however mean that it was not one that was readily available and in 1927 there were twenty three companies in the United States which produced it, 3./ among these being some of the larger galvanised iron rolling mills, perhaps an indication that though not as popular many other galvanised iron products it was nevertheless one worthy of attention from mainstream producers. 4./

V-Crimp roofing was applied directly onto rafters using what was known as a "V-Stick" or "V-Strip". 5./ (Figure 2) These "V" shaped sticks were designed to fit into the crimps in the sheet and to lie across rafters. The sheet was attached to the V-Stick and rafter by means of nails hammered in through one side of the crimp. (Figure 17) In this way the crimped edge was lent extra strength by the

V-Stick and eliminated the use of purlins. At the same time the nail hole was elevated above the level of any water runoff and was thus not a point of leakage. Similarly the V-Crimp deflected water away from the joins between sheets.

The ARMCO catalogue shows that, like most other galvanised iron roofing materials, V-Crimp was available in 22, 24, and 26 gauge sheets measuring 5-10 feet in length and being 24 inches wide. 6./ As has already been stated standard sheets came with a "V" shaped crimp along either side, (Figure 15) but 3 V-Crimp, with an added crimp down the middle of the sheet, 7./ was also available. (Figure 16) Other variations included a version by the Moesch Edwards Corrugating Company of Covington, Kentucky, which was developed in 1912. This V-crimp, marketed under the "Justrite" brand name had, in addition to a triple crimp, an extra crimp added alongside each of the edge crimps, this being done to add strength to the sheet in such a way that it was claimed it no longer needed the support of V-Sticks. This also provided for a double overlap and hence better protection against moisture. 8./ Another innovation, also from 1912, was a side locking device not that much different to those found on sheet metal shingles.

(Figure 9) This was introduced by the Chattanooga Roofing and Foundry Company and was advantageous in that it enabled nail holes to be concealed beneath the upper sheet. 9./

There is almost no record of the type of building on which V-Crimp roofing would be used and, tough generaly referred to as roofing material the only photograph which apparently illustrates its use seems to show it as a siding material. 10./ It is nevertheless another interesting example of the use of galvanised iron and is a good example of how the inherent strengths of the corrugating, or in this case, crimping proces, can be used to maximum advantage.

SPECIALISED SIDING

Specialised sheet metal sidings, most of which sought to imitate some other building material, were an important feature of the galvanised iron market, and were probably the most popular galvanised iron siding products in the urban and suburban context, being used on both shop fronts and housing. As has been demonstrated, other galvanised iron products were generally developed as roofing materials, but this did not prevent their use as siding. Corrugated iron was probably the most common galvanised siding material, but its use on domestic buildings was generally restricted to frontier situations and, unlike the products being discussed here, it would have been unusual as a siding material in the urban and suburban context. From fairly early in its development as a building material iron was used to imitate other building materials and in the third quarter of the 19th century cast iron buildings of this genre were fairly common. Sheet metal seems to have continued these developments after cast iron was discredited due to its instability in the event of fire. Sheet metal shop fronts, using specialised siding materials in combination with decorative panels were extremely popular in certain areas in the late 19th and

early 20th Centuries, but will not be discussed here since the predominant function of such facades seems to have been more for decorative purposes than to provide a cladding for buildings.

The products discussed in this chapter came in essentially three forms. The most common appears to have been what was known as stone or rockface and was a pressed imitation of various stone finishes. Imitation brickface was also common, (Figures 28 and 29) as were imitation clapboards. (Figure 24) Other specialised sidings included imitations of other forms of wooden siding, 1./ and stucco finishes. 2./ In many cases, particularly with regard to brick and stoneface, it was recommended that special coatings be applied to these sidings in order to complete the effect of the material being imitated. Such finishes were acomplished by means of sanding, a process whereby sand was applied to the final coat of paint while it was still wet. 3./

Objections to such imitation building materials would have been fairly strong in the 1870's and 80's and in 1881 Carpentry and Building notes with some satisfaction that galvanised iron is no longer seen as a substitute for brick or stone and that the material is being put to "more practical and tasteful use" such imitations having

only produced "buildings which are eyesores to all who have artistic perceptions." 4./ Carpentry and Building is however commenting on an exhibition in Massachusetts and as has already been commented, upper-class East Coast aesthetic perceptions do not seem to have much concerned the population of less sophisticated regions of the United States.

The comments above do not, however, mean that sophisticated and substantial buildings were not built using these forms of siding, and the same journal, in 1906, carried an article on a large dwelling in St Louis, which building it says was erected "some time ago". This two story balloon frame home had its exterior walls entirely clad in galvanised iron and was finished to resemble sandstone. 5./ Another good example of the use of specialised siding concerns a church, in the upper section of Manhattan, which was probably erected in the late 1880's or early 1890's. This building used a variety of galvanised iron products, having a sheet metal clapboard foundation cladding, stoneface between the foundation and windows, and brickface on the upper sections of the walls. 6./ Admittedly the building was intended to be of a temporary nature and it would seem that such cladding was fairly popular in the prefabrication industry. (In 1914 a company in St. Paul

was even producing rockface portable sheds. 7./) The use of these siding materials does however appear to have been most common on storefronts and in simpler forms of housing, and was also promoted as means giving an existing exterior a new lease on life by means of recladding. 8./

Like most other galvanised iron products specialsed sidings came in large sheets of much the same dimensions as for example corrugated iron (see Figures 24 and 27 for dimensions) and consisted of several courses of stone, brick, or clapboard. Stone and brickface siding appears to have been attached to buildings in much the same manner as metallic shingles and in the early 1890's there is mention of side locking devices much like those used on the shingles. 9./ Metal clapboard sheets were attached to one another in the same way as corrugated iron siding, that is using a single lap and riveting or bolting sheets together, in this case bolts or rivets were put through the bottom edge of the clapboard to avoid leakage. (Figure 3) Cleats, again similar to those used for corrugated iron, were recommended for use with clapboard siding. 10./ It seems that in general stone and brickface siding was applied over sheathing board, 11./ while clapboards, being stronger, due to the manner in which they were crimped, could be applied directly to

structural framing. 12./

The earliest record of the existence of any of the materials discussed in this chapter dates from 1890, the reference in question refering to "imitation pressed brick" which is described as a new form of building material. 13./ (Figure 44) It is quite likely that forms other than brickface were manufactured before this time, but no reference to the periods in which they may have become available has been found.

As with most galvanised iron materials one of the principal advantages of imitation sidings was that they were fireproof, 14./ and apart from being promoted as costing less than the materials they sought to mimic, wood immitations in particular, were said to be as safer from fire than were, for example, genuine clapboards. 15./ This was a justification for its use in the face of critisism on the grounds of aethetics and was a fact of which producers seem to have made much. In 1895 the New York Iron Roofing and Corruating Company devoted an entire page of its ten page catalogue to the promotion of the fireproof qualities of its siding products. 16./

Despite <u>Carpentry and Building's</u> belief in 1881 that

galvanised imitations of other building materials were no longer fashionable they were still thriving in the 1920's, essentially being used in the Mid-West. 17./ In 1927 there were twenty four companies producing various types of stoneface, most of them being based in Ohio, Illinois and other Mid-Western states, while imitation wood siding was being produced by fifteen companies mostly situated in Ohio and West Virginia. 18./ It is interesting to note that in 1927 there was not one producer of imitation siding based in the North-East, 19./ perhaps a further indication of the aesthetic unacceptability of these products in that region, and of their popularity elsewhere, despite their being looked down upon in the centres where fashion was supposedly set.

GALVANISED IRON SEAMED ROOFING

Seamed roofing was, in the early days of sheet iron manufacture, a roofing type more closely associated with tin, 1./ and in general this remained the case throughout the period under discussion. That is not, however, to say that it was not a technique used on galvanised iron roofs, and trade catalogues and journals from the period show that there were many producers of the various types of materials required for the different methods of laying seamed roofs. This form of roofing in general seems to have been aestheticly more acceptable than most other types of galvanised roofing, 2./ but also demanded a greater degree of skill in laying and hence cost more, both of which factors would have made it a less attractive material in regions in which galvanised iron was most commonly used. Another cause of greater expense was that this type of roofing material demanded use of only the most high quality materials. Galvanised iron was available in various, unstandardised qualities, 3./ many of which could not, without cracking or losing their galvanised finish, take the bending required to create most seams . 4./

Standing seam was, and still is, the most common form of

seamed roofing and, like all seamed roofing is formed by folding the edges of two sheets together in such a way that they interlock creating a strong, watertight joint. In standing seam roofing this seam is not flat, but stands up at ninety degrees to the plane of the roof. The seam may consist of either a single or double fold in the metal, the latter, being preffered, is harder to produce and demands even higher quality materials than those required for a single fold. (Figure 18) Various tools existed for the production of folds, 5./ but by the 1880's sheets with factory pressed seams, ready to be closed and, if necessary, refolded for a double seam, were available from rolling mills, and reduced the amount of labour required in laying such a roof. 6./ Not much innovation seems to have occurred in the production and method of application of this form of roofing during the period under study, and what little improvement did occur took place in the methods of attaching sheets to the roof.

Generally, seamed roofing, though usually of the same gauges as corrugated iron, is not as strong because it is not crimped or corrugated and must hence be laid over sheathing boards (Figure 19) or an existing wooden roof. (Figure 22) Sheets were held down by means of cleats which were nailed to the sheathing and then folded in

with the seam. Versions of such cleats illustrated in the 1890's, show that in order to effectively hold down both sheets, cleats had to extend above the height of the seam so that once the seam was made they could be folded back over it creating a firmer grip on the roofing sheet. 7./ (Figures 19 and 23) This method of attachment, though still common in the early 1920's, 8./ had, by at least 1911, been improved upon, 9./ this improvement coming in the form of the split cleat which could be folded over the raised edge of the sheet before the seam was made. It was then folded in with the seam. (Figure 5)

Another version of the standing seam roof was the roll and cap roof which was available as early as 1895 if not before. 10./ This form of seam improved upon the conventional standing seam roof in two ways. Firstly it provided a simpler means of producing a seam, that is all folds were made at the rolling mill, the seam being sealed by a cap which fitted over the ridge on each side of the sheet, the two sides of the cap being squeezed together in order to create the seal. (Figure 25) The second advantage of this form of roofing was that it came in rolls containing a fifty foot length of sheeting material. 11./ This roll consisted of ten foot lengths of sheeting joined by a flat, machine made, seam which

was far more watertight than the mere overlapping of sheets by a few inches as was done on normal standing seam roofs. 12./ This meant that this type of roofing could be used on roofs of far lesser gradient than was usual for any galvanised iron roofing and it was recommended where roofs were of a pitch of 2":1' or less. 13./ This form of roofing was also available as simply roll roofing which could be seamed in the usual way (Figure 18) or as a means of capping ordinary lengths of sheeting. (Figure 26)

The flat seam method of roofing does not appear to have been common on galvanised iron roofs, and no mention of its use in connection with galvanised iron in particular was found, though it does seem to have been in fairly common use with other forms of sheet metal. 14./ Another type of seam which was unsuited to use with galvanised iron was the soldered seam, which was very common on tin and lead roofs. The reason for this is that lead solder and the zinc galvanised layer, when combined, form a brittle alloy which would have caused cracking along joins. 15./ Soldering was also said to have weakened the bond between the galvanised layer and the iron sheet it protected and stress on the join, if it did not lead to cracking, would cause the galvanise to rip off the sheet. 16./

As has already been mentioned sheets for seamed roofing came in much the same gauges as those used for corrugated iron and the same can be said of the lengths in which it was manufactured (that is other than rolls which, though of the same gauge and width, came in much greater lengths.) The American Rolling Mill Company in its 1921 catalogue advertises standing seam sheets in 28 and 26 gauge at 24" widths, or 24 and 22 gauge in 25.5" widths, both widths being available in 5-12 foot sheets. 17./ These dimensions are very similar to those of their standard corrugated iron sheets.

Standing seams are said to have had an advantage over flat seams in that they were best able to resist expansion and contraction and this may well have been the reason for their use on galvanised iron, iron being a material which expands and contracts quite considerably. 18./ A further advantage of seamed roofing, and one that is well known, is that it rarely requires maintenance, perhaps a factor mitigating its initial expense. In addition to these qualities, standing seam roofing is said to better channel off water than other forms of seam and this was an additional reason for its popularity. 19./ In general seamed roofing it would appear to have been a desirable

form of roofing for those who could afford it and one which was frequently used in better class neighbourhoods.

GALVANISED IRON SHINGLES SLATES AND TILES

One of the few real innovations, and one which appears to have been unique to the sheet metal industry of the United States is the development of the metallic tile or shingle in the 1870's. Though these could be made of any of the common roofing materials, that is copper, tin, terne plate (another form of iron covered by a protective coating) or plain black iron, the most popular material for their manufacture was galvanised iron. 1./

It would seem that metallic shingles developed in the 1870's, and the first detailed record of their existence is from 1879. In that year, in a general article on roofing materials Carpentry and Building mentions that they have been on the market for some time. 2./ Little is said about their appearance and it is not known what form early versions of this roofing medium took. From later articles it would however seem that they looked much like wooden shingles, were wedge shaped and were applied using traditional methods 3./ (Figure 45) These were not strictly speaking made of sheet metal, a material which was first used in the next decade.

The National Sheet Metal Roofing Company of Jersey City, in their advertising, claim to have been the inventors of the sheet metal shingle in 1885. 4./ Other sources claim the invention took place in 1881 and was by the same company, who were in addition the first to manufacture painted, galvanised and multiple sheet shingles. 5./ This confusion in dates stems from several factors most of which are related to the evolution of this type of shingle. The early wedge shaped versions, some of which were still on the market as late as 1918, 6./ were in the 1880's developed into what seems to have become a more popular and practical form of roofing material. Conflicting dates for the origin of these more innovative sheet metal versions would seem to be connected to the develpoment of various locking and waterproofing devices which were evolved in order to make the material more competitive, both cost and quality wise. In an article in 1914, Metal Worker, Plumber and Steam Fitter credits one, C.B. Cooper, of National Sheet Metal Roofing Company as the inventor of the sheet metal shingle in the year 1882, which shingle it claims was similar to and was used in much the same way as a wooden shingle. 7./ The first patent side locking device was also developed at National Sheet Metal Roofing by a James Walters in 1883. 8./

Metallic shingles were in general designed as an alternative to more conventional roofing materials such as the wooden shingle, slate or tile and in appearance are much the same once applied as roofing or siding. Early problems however seem to have concerned the fact that they were not as efficient as traditional materials and required a steeper pitch of roof to effectively shed the same volume of water as the products they sought to replace 9./ and in addition cost considerably more than other galvanised roofing materials on the market. 10./ Developments in the 1880,s and in subsequent years, attempted to address both these problems through incorporating into the shingles waterproofing devices which reduced leakage, and devices which minimised labour and overlap hence reducing costs.

Walters' side locking shingle was illustrated in <u>Carpentry and Building</u> (Figure 31) in 1884, its main advantage being stated as the fact that it had less overlap than other shingles. 11./ As with all such devices, Walters' side lock is an integral part of the shingle and was manufactured by folding the original metal sheet in such a way as to produce a slot on each side of the shingle enabling individual shingles to clip into one another. When compared to later side locking devices Walters' lock is fairly elementry, but

is nevertheless far in advance of other side locks which appeared on the market shortly afterwards. Hyndman's shingle, which first appeared in 1885, (Figure 33) was nowhere near as advanced as Walters', requiring a cleat which had to be attached to the roof separately and then bent down over the shingle in order to hold it in place. 12./ Like Walters' shingle it does however conceal the nail head under the shingle, thus eliminating a major leakage point.

Some other interesting features of the Walters shingle include the fact that it has a pattern impressed into it in a "Y" shape. This is not only decorative, but is designed to lend the shingle strength in much the same way as corrugated iron sheets are strenghtened. This decoration, when the shingles are laid, interconnects in such a way as to create an overall pattern on the roof, a device used by most subsequent manufacturers. Another advanced feature of this early sheet metal shingle is the presence of what were later termed "anti-capillary grooves". 13./ These are the raised ridges in the top section of the shingle, that is the section of the shingle which is covered by the row of shingles above, and are designed to prevent water from creeping up between the two rows of shingle by ensuring that the surface of the bottom shingle makes very close contact

with the underside of the shingle above it. 14./ (Figure 38) It will be noticed in Figure 31 that the side lock also contains a similar groove which provides a double seal much like that on the top and bottom edges. Like many later shingles the Walters shingle is designed to be laid so that alternate rows are placed half a shingle to one side of the previous row. (Figure 32) This is a waterproofing and strengthening measure which ensures that side lock joints never extend more than a single shingles length.

Following the introduction of Walters' shingle many other manufacturers followed with their own version of locking devices one example of which has already been discussed. Another company, hot on the heals of the National Sheet Metal Company, was Anglo-American Roofing of New York who in 1885 introduced a double shingle. 15./ (Figure 34) This may be the first multiple or cluster sheet shingle, but no dimensions are given for it and it is not known if it was any larger than the first Walters shingles which were available in three sizes, that is 7"x10", 10"x14" and 14"x20". (These are flat sheet dimensions prior to pressing and bending.) 16./ As has already been noted National Sheet Metal and Roofing is credited with the development of these shingle sheets, 17./ that is large sheets pressed out

so that they appear to consist of several individual shingles. (Figure 7) Multiple shingle sheets are connected to one another in the same manner as other single shingles, and were usually produced in conjunction with single tiles which could be used for finnishing at ends of rows. 18./ These sheets once more add to the advances in waterproofing; cost of manufacture and efficiency of laying made by manufacturers since the introduction of first metallic shingles. It is hard to ascertain exactly when production of such sheets began and the first record of their existence found, was in an advertisement from 1891. (Figure 40), however, development of multiple sheets must have occurred quite sometime before then.

Another early version of the side lock shingle is the Hamsley shingle also first marketed in 1885, initially by George E. Cooper of Nashville, and later by Hamsley Metal Roofing of New York. 19./ (Figure 35) This version, although possesing only a small corner clip instead of a full side lock, is interesting in that it was designed to be mounted diagonally giving a diamond effect. It also had an unusually shaped anti-capillary device which appears to have been designed to prevent moisture from running down the inside of the joint and

collecting at the shingle's most vulnerable point, its corner clip. Instead moisture is deflected onto the exposed surface of the shingle where it would evaporate.

By the advent of the 1890's there were several other manufacturers of sheet metal shingles of various types with advanced versions of the initial Walters side lock mechanism and this same system continued to develop in various forms up to the 1920's 20./ (Figures 1, 4, 6, 10, 11, 36, and 37) and
included more complicated designs than the initial shingle or slate imitations. Many manufacturers produced tile imitations, one of the more popular versions being a "Spanish tile" form (Figure 10) though simpler imitation ceramic forms did exist. (Figure 13) Some highly specialised shingles were also produced, an example of which is a tile specifically designed to fit on conical roofs and curved surfaces. This was produced by Merchant and Company of Philadelphia. 21./ Many early designs, however, remained popular for many years, including Walters' original shingle which was still being advertised in 1920. 22./

Sheet metal shingles were laid in much the same way as any conventional wooden shingle or tile roof, that is on

a wood sheathing which was first applied over the rafters, 23./ and which process can be seen in Figures 32 and 35. An insulating layer of non-acidic sheathing paper could also be applied between the shingles and sheathing board, 24./ as in Figure 7. Application was from left to right beginning with the bottom row of shingles, and shingle edges were usually bent over at roof edges to form a flashing. 25./ Metal shingles could also be used as a siding material. (Figure 41)

Metallic shingles do not appear to have been an immediate success and were never as common as other galvanised iron cladding products. Carpentry and Building does however comment in 1901 that they were gaining in popularity 26./ and of all the galvanised iron roofing products available they would appear to have been the ones most suited to use in a suburban environment where objections on the grounds of aesthetics would be more voluble. They had several advantages over more conventional roofing materials most of them related to the general properties of galvanised iron, that is their light weight and resistance to fire. In addition they became economically a better choice in unwooded areas where wooden shingles had to be brought in from afar, or in terms of the general rise in cost of wood products in this period as forest resources

diminished. In addition they were said to have an advantage over other galvanised iron products in that a metal shingle roof was not as airtight allowing a certain amount of air circulation and hence to a degree preventing heat build-up or condensation on the underside of the roof. 27./

As has already been mentioned one of the biggest disadvantages of metallic shingles was that they did not shed water as effectively as other materials and hence had to be used on roofs of a steeper pitch. Despite the advances in locking devices and sealing mechanisms, by the late 1920's this remained a problem and it was still recommended that they only be used on steeply pitched roofs. 28./ This not only restricted the type of building such shingles could be used on, but also determined that they were more expensive to use since the steeper a roof the greater its surface area and hence the larger the quantity of material required to cover it. Other problems encountered include the fact that in areas of climatic extreme Sheet metal shingles were found to be unsuited to the expansion and contraction they were required to undergo, and sidelocks often sprang causing leaking. Nevertheless, and despite various drawbacks, in 1927 forty seven companies in the United States were producing metal shingles or tiles and

they must have been a reasonably profitable buisness.
29./

Of all the products discussed in this dissertation the metallic shingle is probably the most uniquely American, and seems to have answered a need in a society which, though not developing in the sense of much of the rest of the world of its day, and hence not able make do with the rough and ready products generally associated with galvanised iron, nevertheless required a building material which was suited to the development of new areas and was at the same time presentable. Sheet metal shingles being lightweight, strong, easily transportable and reasonably cheap were also more sophisticated than other products with the same attributes and seems to have met a need in the society for which they were developed.

INNOVATION IN GALVANISED IRON BUILDING TYPES

Many of the types of building upon which galvanised iron was used have already been mentioned and it is not the intention of this chapter to focus too heavily on the more general and thus well known uses of this material in construction. Instead the more innovative uses of the galvanised iron will be discussed with particular reference to the manner in which it was meeting both old and new needs in the society of which it was part.

Perhaps the most noticeable area in which galvanised iron proved its ability to meet new needs relates to the invention of the automobile. Not generally considered of architectural importance, the suburban garage was a product of the automobile age and one which, with the increased popularity of automobiles, became increasingly common in America as the 20th Century progressed. By 1925 it was estimated that up to 650,000 garages were erected in the United States each year and sheet metal workers were producing many of them. 1./ The earliest mention of sheet metal garages found was in <u>Metal Worker, Plumber and Steam Fitter</u> in 1911 and concerns a discussion of a portable version of this building type. 2./ In a brief description the following year the

journal recommends that such structures be built using a wooden frame covered with light galvanised sheeting on the exterior, and, if desired,a lath and plaster interior. 3./ By 1914 the same journal mentions that such structures are becoming popular as both permanent and temporary buildings. 4./

The advantages of galvanised iron for the building of early garages is closely related to one of the dangers of early motoring, that is the fact that fuel tanks on automobiles did not seal well and escaping gasoline fumes were a fire hazard. In a detailed article on garages in 1920, Metal Worker, Plumber and Steamfitter describes this hazard and recommends that any garage structure erected within thirty feet of another building should be built entirely from metal due to that material's fireproof qualities. Wooden framed buildings, it was claimed, were still a danger even if clad with sheet metal and should only be erected further than thirty feet from other buildings. To emphasis the danger from gases produced by motor vehicles the same article recommends that the floor of any garage be built at slight slope so that gases such as carbon monoxide, carbon dioxide and gasoline fumes, all of which are heavier than air, could escape from the building. Vents in roofs were also thought to be essential. 5./

Municipalities seem to have been aware of the advantages of sheet metal for use in garage construction, and revised building codes which often discriminated against the use of the material. For example: in New york in 1917 the building code was revised to allow for the erection of single storey metal buildings for use as garages. All parts of the building other than the doors, windows and roof were permitted to be metal and structures had to be less than fifteen feet in height and could not exceed 1,250 square feet in area. 6./

Agriculture was another area in which sheet metal became popular after the turn of the century, and there are numerous articles urging sheet metal contractors to exploit the rural market. Galvanised iron could be used on just about any building in the agricultural context and a 1915 article in Metal Worker, Plumber and Steamfitter describes a farm in Maine where every building on the property, including the house, barn, shed, creamery, pigpen and henhouse, had been covered with galavanised iron. 7./ As was mentioned in an earlier chapter the use of the material in this way was actively encouraged by the Department of Agriculture since it was regarded as a quick and easy way for farmers to improve their facilities at minimum expense

and at the same time greatly increase the safety of their buildings. 8./

One of the principal manners in which galvanised iron used on agricultural buildings was as a cladding to be placed over the existing, usually wooden, exterior. 9./ This practice, also common on other building types, gave structures a new lease on life. Another advantage of galvanised iron in agriculture was that it was far more pest proof than most traditional building materials, and from approximately 1905 galvanised iron silos and other metal storage facilities were being produced. 10./

The Federal Government was another user of galvanised iron buildings, mainly in the military sphere, though there is a mention of their use on Indian Reservations. 11./ It is well known that galvanised iron was used for a variety of military building purposes during the Second World War and it was also used during World War I, though not as extensively as might have been expected. There is mention in an advertisement in 1912 that sheet metal "balloon houses" (that is hangers for blimps) were being produced, 12./ and during the war itself there is an article describing metal hangers for use by flying machines. These hangers were produced by companies which before the war had specialised in the

manufacture of garages. 13./ The same article mentions that the " Government has put its taboo on metal buildings (that is for civilian use) that this metal may go into hangers for more martial ends." 14./ Another common form of sheet metal building used by the army was for ammunition storage, 15./ and in general it would seem that unless there was a fire danger buildings were constructed from materials other than sheet iron, metals being reserved for use in more vital areas of the conflict.

In the initial stages of America's entry into the war metal barracks were used by the army, but their production was curtailed due to metal shortages in other areas. 16./ By and large barracks in World War I were constructed using the cheapest materials available, that is they were wood framed with various types of composition siding and roofing. 17./ Although these materials were not as durable as galvanised iron they could be erected with the same speed and its was claimed that a 200 man barrack could be ready for habitation within ten hours of the site having been surveyed. 18./ The metal barracks used in the earlier part of the war were designed in prefabricated sections so that buildings could be built in various lengths and widths, usually 20-25 foot wide and 60-80 foot long, but

apparently some were as long as 325 feet. 19./

On the subject of prefabrication this was probably the area in which galvanised building was developing most rapidly. Prefabrication in metal was first used on bridges sent to the colonies from British foundries such as the one at Coalbrookdale, and Gilbert Herbert contends that the use of iron in construction quite naturally led to its use as a prefabricated material since when it is used little preparation can be done on site and members must generally be made in standard sizes in the foundry. 20./ By the 1830's ships were being manufactured in one place and assembled in another and a decade later the first iron buildings were being shipped across the oceans of the world. 21./ In the 1850's many such buildings were being manufactured for the California Goldrush including the first examples made in the United States using materials exported from elsewhere. 22./

Charles Peterson, in an article on early American prefabrication, argues that the reason for the late development of prefabrication this country was due to the abundance of wood in areas of early settlement and the resultant fact that early prefabs, most of which were wooden, were not required in this country until the

discovery of gold in California in 1848. 23./ In California, despite the abundance of trees, there were insufficient saw mills and skilled builders to cater for the building needs of the burgeoning population and buildings had to be brought in from elsewhere. These buildings, many of them iron, where shipped from as far away as China and New Zealand, but, as has already been mentioned, 5,000 were made in New York. 24./ The American prefabrication industry was given a further boost during the Civil War and in general it would seem that throughout the 19th Century there was a steady demand for such buildings in newly opened up regions of the country. 25./

Not much information on the development of galvanised iron prefabrication exists for the early part of this study, and indeed it would seem that most prefabricated buildings in the period were made from wood. From the turn of the century there appears to have been an increase in the area of sheet metal prefabrication, and in 1914 the industry was producing both permanent and temporary buildings for a variety of uses. Among these were buildings for mass housing for railroads, mining camps and plantaions; garages and a variety of buildings for storage. 26./

Some examples of prefabricated building types from the 1890's were found, and one in particular appears to have been fairly advanced for its time. This corrugated iron dwelling, produced by the Iron Cottage Company of Grand Rapids, could be erected by two men. (Figure 39) It appears to have required a minimum number of bolts, the entire wood and iron frame being held in place by means of slots in framing members and tightening rods which were located just below the rafters. In a similar manner siding and roofing panels slid into groves in the frame and were only held in place by a few bolts. Panels were lined with insulating materials the interior surface being a form of canvas which could be painted. These cottages were considered suitable for "summer resorts, contractors, bath houses, summer kitchens, dormitories, camping parties, cheap residences" etc. etc. and were completely portable. They were available in two sizes, style number 1 being 10 feet wide and any length desired, while number 2 had a living room kitchen and two bedrooms (no dimensions given). 27./

As has already been mentioned garages were from an early stage prefabricated. One producer, Duluth Corrugating and Roofing Company, was in 1911 making knockdown garages which could be crated and shipped. These garages came in a single 26'x36' size and the estimated time it

would take for two men to erect the building was two days. It used a fairly elementary system of construction in which metal panels were bolted onto a metal frame, these panels were not lined in any way, but the interior could be plastered over using metal lath if such a finish was desired. 28./

In 1920, the firm of William Buchanan of Brooklyn was producing similar garages, but in a variety of sizes and using two methods of construction. The first type was an all steel garage using angle iron framing materials. This building was available using either 26 or 24 gauge galvanised sheeting and had a corrugated iron roof and pressed steel side panels. The second version was available with a wooden frame and used 26 gauge galvanised iron clapboards as siding, again in combination with a corrugated roof. Both models came in four sizes ranging from 10'x14' up to 20'x20' and could be ordered in double or larger units. A single 10'x18'x8' all metal garage weighed 11,550 lbs and had 209 component parts. 29./

As prefabricated building developed, more unique and efficient methods of erection evolved especially where buildings were designed to be moved and re-erected time and again. One such building was the "Kahn Portable

Steel Building" designed circa 1915. This building, manufactured by the Trussed Concrete Steel Company of Youngstown, Ohio, required no loose bolts at all and was assembled using a key which turned the locking devices which held panels together. The building had no separate frame and when knocked down consisted only of the heavy gauge panels from which it was made. No dimensions are given for this building system but it is stated that it could be used as a temporary hospital, shcool or firehouse and was also used as temporary housing. 30./

Similar ingenious systems were developed for the agricultural sector which was an ideal market for prefabrication being isolated from practioners of conventional building methods. As has already been mentioned sheet metal silos were already available shortly after the turn of the century and by 1915, if not earlier, these could be purchased in sections which could be shipped and erected anywhere, and if desired moved about the farm. 31./ A more unusual portable products designed for use in agriculture in the 1920's was a corrugated iron haystack cover designed with large corkscrew like attachments on its underside, these being screwed into the top of the haystack. (Figure 21) This product was available from the Martin Metal Manufacturing Company of Wichita, Kansas. 32./

Although it is difficult to find descriptions and other information relating to specific prefabricated structures, that is not to say that such structures were not being manufactured in large quantities. The 1927 handbook of the Sheet Steel Trade Extension Committee, 5000 Sheet Steel Products and Who Makes Them, lists literally hundreds of manufacturers of sheet steel buildings under one hundred and three separate building types. These buildings range from factories through a variety of agricultural, residential and commercial types demonstrating once again just how versatile a building material galvanised iron was. 33./

CONCLUSION

> "During the last third of the Ninteenth Century the prefabricated corrugated iron building had become commonplace and unspectacular. The lay press no longer gave publicity to buildings for export, for the novelty had worn off; the professional journals disdained to illustrate corrugated iron buildings for, aesthetically, they were incompatible with the ruling taste and, technically, they were no longer exciting - they were, however, undoubtedly a fact of life." 1./

The above qoutation from Gilbert Herbert's Pioneers of Prefabrication, a work dealing in detail with the early development of the galvanised iron industry in Britain, though it refers specifically to corrugated iron, illustrates quite well the position of the building material from the 1870's up to the present day.

Never what most people would term "attractive", galvanised iron was, when it was introduced in the 1830's, a focus of curiousity in an age which was constantly delighted by technolgical innovation. By the begining of the 1870's, however, and despite the fact that large sheet iron rolling mills were only just begining to develop in the United States, attitudes of American journals seem to have been fairly similar to what Herbert says of the British press. In America

architectural journals rarely refered to galvanised iron, and in Britain on the few occassion when the material was dicussed it was usually in order to critisis its aesthetic qualities and to laud restrictions placed on its use by means of municipal bylaws. 2./

Herbert contends that for the galvanised iron industry the late Ninteenth Century was a time of market consolidation an expansion of production, and was not an era noted for technical innovation. 3./ This may be true of British and other European galvanised iron industries, but, as has been demonstrated, in America the state of the industry was somewhat different. Many new and useful forms of galvanised iron cladding and roofing were put on the market in the fifty years following 1870 and, even though it does seem that the corrugated sheet dominated the market, that market did continue to diversify and many new ways of linking, pressing and forming galvanised iron were developed for the building trade. This was not the only way in which American production differed from its European counterparts. New products opened up new markets and instead of being restricted to industrial and temporary buildings or housing only suited to frontier situations, galvanised iron roofing in particular became a product

which was extensively used in suburban America.

It is difficult to understand exactly why galvanised iron roofing and cladding should have developed further in the United States than it did elsewhere, and the reasons for this should be looked for in several areas, one such being the nature of American society at the time. The United States was developing at a rapid rate and required a more innovative approach to lightweight fast assembly building materials than was needed in the other industrial nations of the world. The American public was, however, aesthetically more aware than were the populations of those developing countries for which much European galvanised iron was produced, but, by the same token, was not in general as predjudiced against it as were the more sophisticated societies of Europe. For this reason in many regions of the country galvanised iron, if given some attention as regards its appearence, seems to have been quite acceptable as a domestic building material. Another reason for innovation in American galvinised iron products was probably due to the fact that sheet iron rolling mills were slow in developing because of competition from Europe and lack of protection for local producers. This may have created a need to produce articles which were unique to local industry and which not only gave it its

own identity, but created a local market for local products.

Whatever the reason for the fact that some unique galvanised iron products developed in the United States, it seems that Gilbert Herbert's contention that the market was no longer a developing one applies only to certain products in this country. The idea that the public lost interest in galvanised iron, though true from the point of view of the publicity the material engendered, does not apply when consideration is given to the number and variation in the type of buildings upon which the material was used. Those who determined the aesthetic standards of the day may for a variety of reasons not have placed their stamp of approval on the use of galvanised iron on certain building types, but that does not apppear to have detered most people from using it as and when they pleased.

In examining the history of a building material of this type it would seem that there are more important aspects to its use than purely its aesthetic qualities and, as has been pointed out time and again in this study, galvanised iron was a product which, due to its many other qualities, was able to transcend critisisms levelled against it. It was and is still useful for its

practical qualities and from the 1870's onwards, in both its old and new forms, continued to meet practical requirements as a cladding and roofing material in this country.

ILLUSTRATIONS

LIST OF ILLUSTRATIONS:

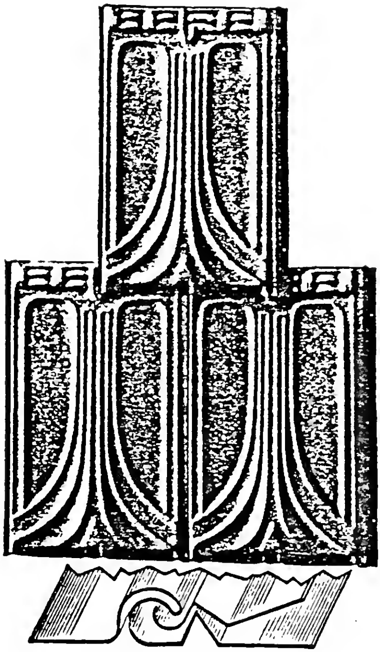


FIGURE : The Edwards Interlocking Shingle

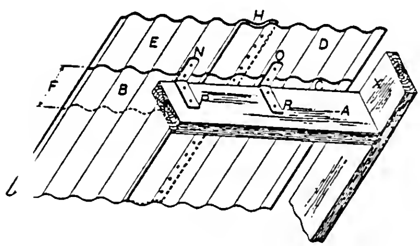
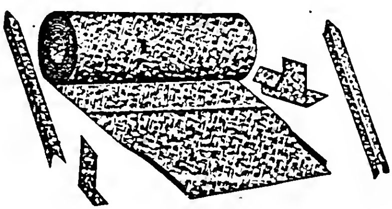


FIGURE 2 Fastening Corrugated Iron to Wood

WHEELING CORRUGATING COMPA NY

Roll Roofings—Galvanized or Pain ed



MADE from Open Hearth Steel. Ready to lay without further repa-ration. Just the article for Dealers t Han-dle. Just ready for roofers to pply. That Roofing Contract can be con leted sooner if you use our Rolls than you attempt to lock and solder your own eams. Time is money and time saved on one contract will see another well n its way.

Large stocks at all stores. Prompt Shipments. Quality material.

WHAT ARE YOUR REQUIREMENTS?

WHEELING CORRUGATING COMPANY, WHEELING,V VA.

BRANCH OFFICES AND STORES:

NEW YORK CHICAGO PHILADELPHI.
ST. LOUIS CHATTANOOGA

FIGURE 5: Wheeling Corrugating Company, Roll Roofings

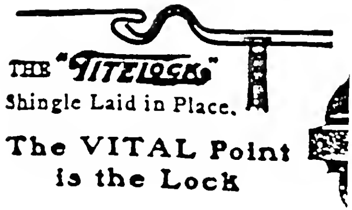


FIGURE 6: Milwaukee Corrugating Company,

Shingle Locking Device

FIGURE 7: The Metal Shingle Company, Shingle Clusters

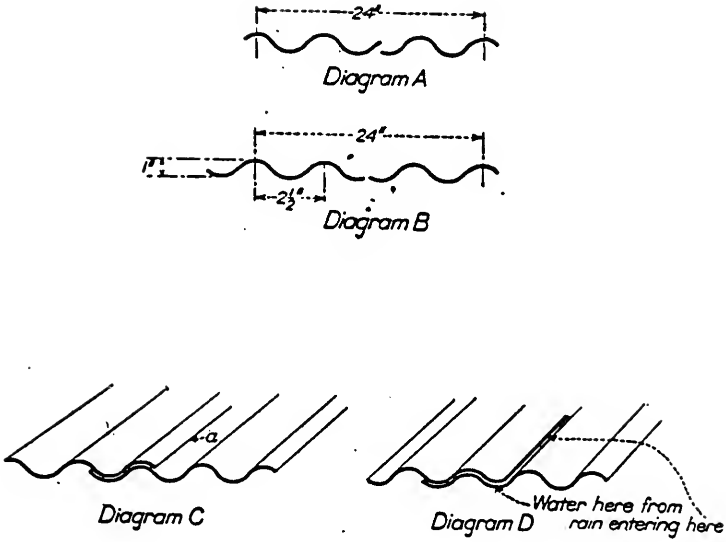


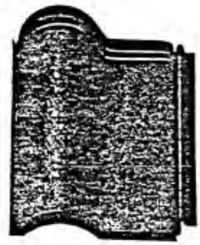
FIGURE 8: Methods of Lapping Corrugated Iron

This cut shows Method of Locking Sheets

This cut shows Sheets Locked

FIGURE 9: Chattanooga Roofing and Foundary Company, V-Crimp Locking Device

Edwards Metal Spanish Tile



Is being advertised in the leading magazines and now known to thousands of home builders and owners everywhere. Wherever it has been used it has made a decided "hit" because it shows off to good advantage on the roof and has numerous points of superiority over any other style of roofing.

Architects are specifying Edwards Metal Spanish Tile, for they know it will do away with roofing "troubles." Builders like it because of the finished appearance it gives any house on which it is used.

Our Metal Tile are stamped out of the highest quality Worcester terne plate in exact imitation of the most expensive Terra Cotta Spanish Tile. They come either "dip" painted or heavily galvanized; size 10x14 inches. Our patented interlocking side lock makes it possible to make a perfectly moisture-proof roof without soldering. Edwards Metal Spanish Tile afford the fireproof advantages of Terra Cotta Tile, but are much lighter in weight, cost but a trifle more than ordinary roofing and will last a lifetime.

WRITE US TO-DAY ABOUT YOUR TERRITORY. Our business is growing so rapidly that it is necessary to have an agent in every community. The territory is going fast. One day's delay may mean that some one else will be given your territory. DON'T DELAY. WRITE TO-DAY FOR OUR SPECIAL TILE PROPOSITION.

The Edwards Manufacturing Co.

"THE SHEET METAL FOLKS"

415-435 Eggleston Avenue **CINCINNATI, OHIO**

New York Office: 81-83 Fulton Street. Branch Office and Warehouse: 1625-1627 Pacific Avenue, Dallas, Texas.

Note the construction of patented interlocking device, protecting nail-heads from weather and providing perfectly for expansion and contraction of the metal.

FIGURE 10: Edwards Metal Spanish Tile

FIGURE 11: Walter's Shingles in 1913

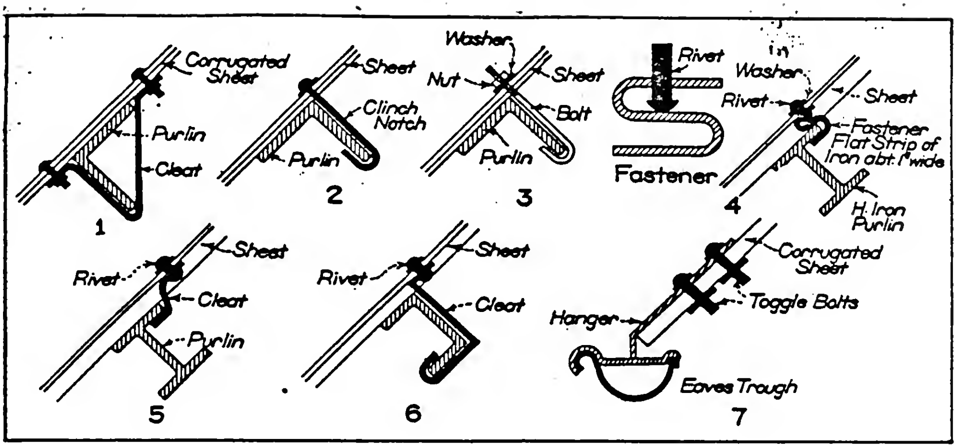


FIGURE 12: Methods of Fastening Corrugated Iron to Metal Frames

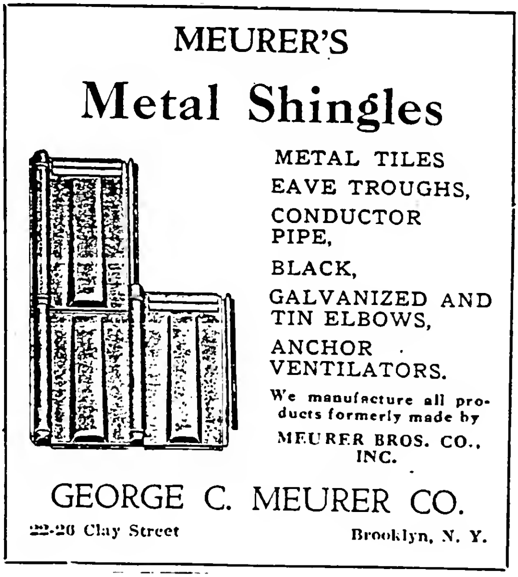
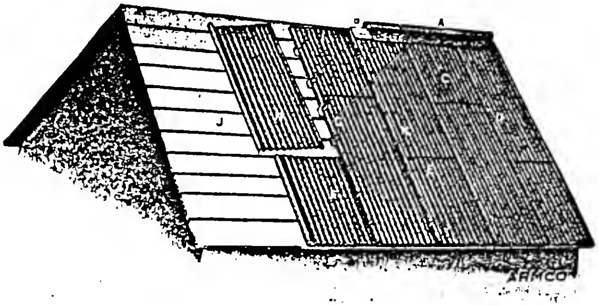


FIGURE 13: Meurer's Metal Shingles

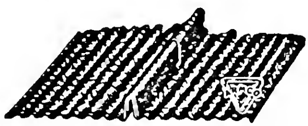
"ARMCO" INGOT IRON

CORRUGATED SHEETS, SUPPLIED WITH PRESSED STANDING SEAM EDGES

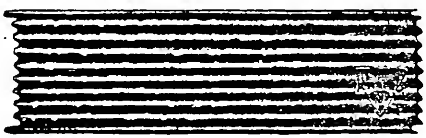


Pressed Standing Seam Corrugated Roofing Laid

A—Combing Cap. B—Wood Filler. C—Roof Finished. D—Standing Seam, finished. E—Cross-Joint nailed. F—Sheet in place, cleat turned, and seam squeezed. G—Cleats in place at side of sheets. H—Sheet ready to put in place to finish course. J—Sheathing Strips.



Mode of Finishing Standing Seam when laid as Roofing



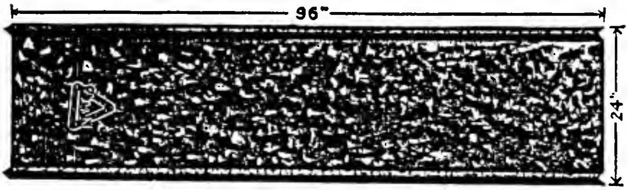
Shows Corrugated Iron supplied with Standing Seam

FIGURE 14: Standing Seam Corrugated Iron Sheeting

"ARMCO" INGOT IRON

V-CRIMP ROOFING

MADE OF INGOT IRON GALVANIZED SHEETS



Regular V-Crimp Roofing as shipped

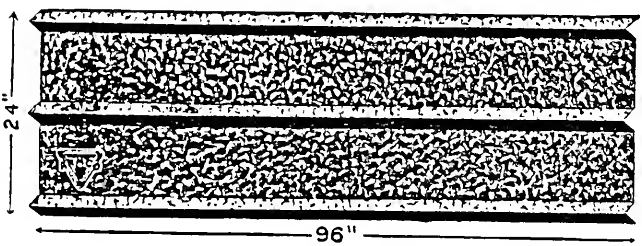
V-Stick used with V-Crimp Roofing

FIGURE 15: V-Crimp Sheet and V-Stick

"ARMCO" INGOT IRON

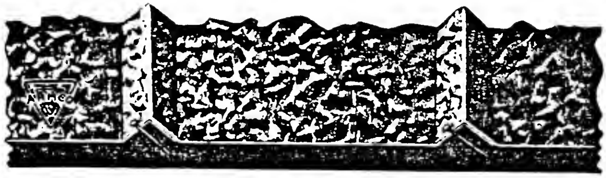
THREE V-CRIMP ROOFING

MADE OF INGOT IRON GALVANIZED SHEETS



V-Crimp Roofing with Three Crimps or Center Crimp
This style is never shipped unless specially ordered

FIGURE 16: Triple V-Crimp Sheet



Cut shows where to Nail V-Crimp Roofing]

FIGURE 17: Method of laying V-Crimp Sheets

"ARMCO" INGOT IRON

4-X GRADE DOUBLE CROSS-LOCK ROLL ROOFING

MADE OF INGOT IRON GALVANIZED SHEETS

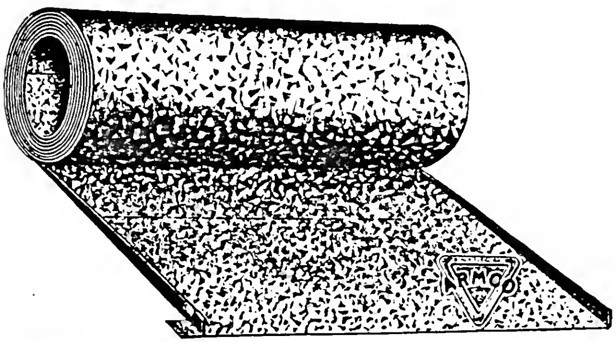
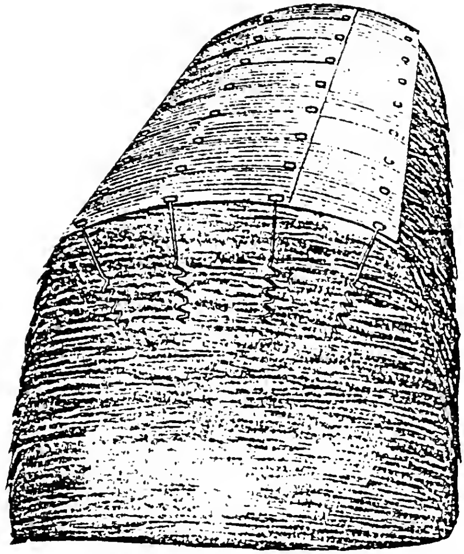


FIGURE 18: Standing Seam Roll and Method of Creating a Double Standing Seam



This portable sheet steel hay stack cover gives the entire stack the protection of a barn. The cross section view through the stack shows how the screws tie the cover to the stack.

FIGURE 21: Martin Metal Manufacturing, Portable Haystack Cover

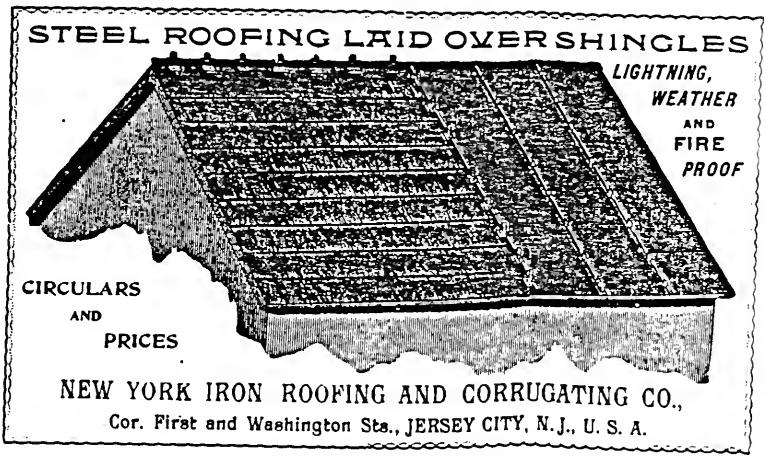
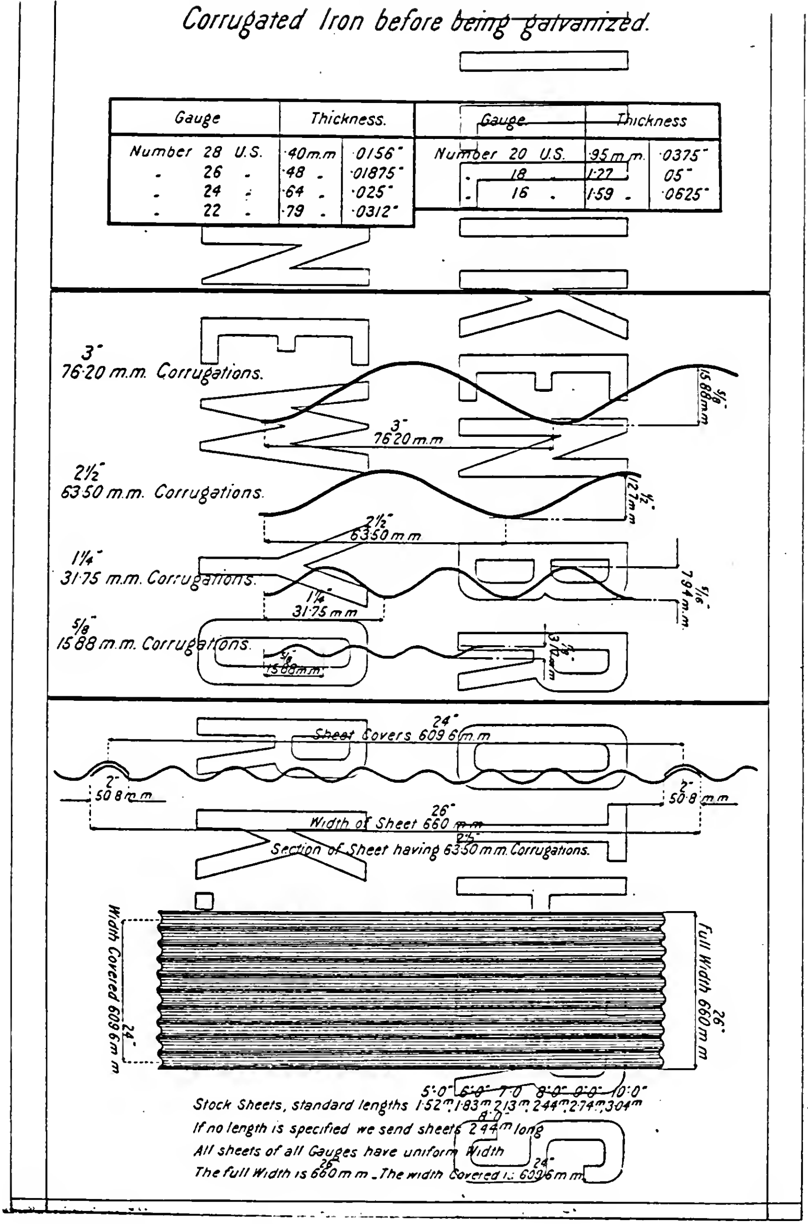


FIGURE 22: Standing Seam Roofing Laid Over Shingles

FIGURE 27: New York Iron Roofing and Corrugating Company, Brickface Siding



Gauge		Thickness	
Number 28 U.S.	·40 m.m	·0156"
26	·48	·01875"
24	·64	·025"
22	·79	·0312"
Number 20 U.S.	·95 m.m.	·0375"
18	1·27	·05"
16	1·59	·0625"

FIGURE 28: Milliken Brothers, Corrugated Iron Profiles and Gauges

CORRUGATED IRON 2½" PITCH.

U. S. Standard Gauge.	Thickness of Sheet in Inches.	Weight of 100 Square Feet in Pounds.							
		Loose Sheets.		Galvanized Iron Laid, Adding for Laps—for Sheet Lengths of:					
		Black.	Galvanized.	5'	6'	7'	8'	9'	10'
20	.0375	167	184	210	208	207	206	206	205
22	.0313	139	156	178	176	176	175	174	174
24	.025	111	128	146	145	144	143	143	143
26	.0188	83	101	115	114	114	113	113	113

NOTE.—If material is to be painted add 2 pounds to the above weights of 100 square feet.

This table is based on galvanized corrugated sheets 27" wide and ⅝" deep, 2½" centre to centre of corrugation.

Before corrugating, sheets are 30" wide.

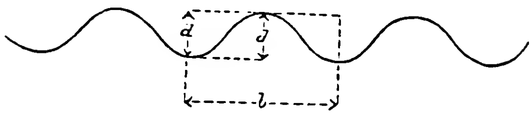


TABLE OF SAFE AND CRIPPLING LOADS IN POUNDS PER SQUARE FOOT.

U. S. Standard Gauge.	Safe Load.				Elastic Limit.				Crippling Load.			
	Span in Feet.				Span in Feet.				Span in Feet.			
	3	4	5	6	3	4	5	6	3	4	5	6
20	59	44	36	30	89	67	54	45	134	100	80	67
22	48	36	29	24	71	54	43	36	107	80	64	54
24	37	28	22	19	56	42	34	28	84	63	51	42
26	31	23	18	16	44	34	27	23	69	52	41	34

FORMULA:

$$W = \frac{98000\, t\, b\, d}{l}$$

W = Crippling load in pounds per square foot.
t = Thickness of metal in inches.
b = Centre to centre of corrugation in inches.
d = Depth of corrugation in inches.
l = Length of span in inches.

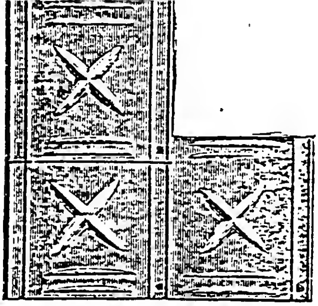
FIGURE 29: Weight and Load Charts for Corrugated Iron Sheets

WEIGHT OF ROLLED SHEETS.

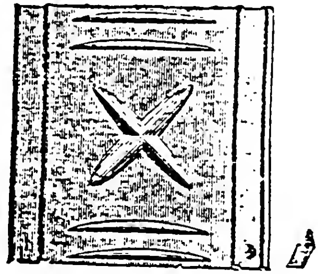
Calculations based on Specific Gravity of 7.85.

No. of Gauge.	Birmingham Wire Gauge and English Standard Gauge.		American (B. & S.) Wire Gauge.		New U. S. Standard Gauge, 1893.	
	Thickness in Inches.	Weight per Sq. Ft.	Thickness in Inches.	Weight per Sq. Ft.	Thickness in Inches.	Weight per Sq. Ft.
0000	.454	18.52	.460	18.76	.406	16.58
000	.425	17.34	.410	16.72	.375	15.30
00	.380	15.50	.365	14.88	.344	14.03
0	.340	13.87	.325	13.26	.313	12.75
1	.300	12.24	.289	11.80	.281	11.48
2	.284	11.59	.258	10.52	.266	10.84
3	.259	10.56	.229	9.36	.250	10.20
4	.238	9.71	.204	8.33	.234	9.56
5	.220	8.98	.182	7.42	.219	8.93
6	.203	8.28	.162	6.61	.203	8.29
7	.180	7.34	.144	5.88	.188	7.65
8	.165	6.73	.129	5.24	.172	7.01
9	.148	6.04	.114	4.66	.156	6.38
10	.134	5.47	.102	4.15	.141	5.74
11	.120	4.89	.091	3.70	.125	5.10
12	.109	4.44	.081	3.29	.109	4.46
13	.095	3.87	.072	2.93	.094	3.83
14	.083	3.38	.064	2.61	.078	3.19
15	.072	2.94	.057	2.32	.070	2.87
16	.065	2.65	.051	2.07	.063	2.55
17	.058	2.37	.045	1.84	.056	2.30
18	.049	1.99	.040	1.64	.050	2.04
19	.042	1.71	.036	1.46	.044	1.79
20	.035	1.42	.032	1.30	.038	1.53
21	.032	1.30	.028	1.16	.034	1.40
22	.028	1.14	.025	1.03	.031	1.28
23	.025	1.02	.023	0.921	.028	1.15
24	.022	0.898	.020	0.821	.025	1.02
25	.020	0.816	.018	0.729	.022	0.89
26	.018	0.734	.016	0.651	.019	0.77
27	.016	0.653	.014	0.581	.017	0.70
28	.014	0.571	.013	0.515	.016	0.64
29	.013	0.531	.011	0.459	.014	0.57
30	.012	0.489	.010	0.409	.013	0.51
31	.010	0.408	.009	0.364	.011	0.45
32	.009	0.367	.008	0.324	.010	0.41
33	.008	0.326	.007	0.288	.009	0.38
34	.007	0.286	.006	0.257	.009	0.35
35	.005	0.204	.006	0.228	.008	0.32
36	.004	0.162	.005	0.204	.007	0.29

FIGURE 30: Birmingham Wire Gauge and U.S. Standard Gauge Chart

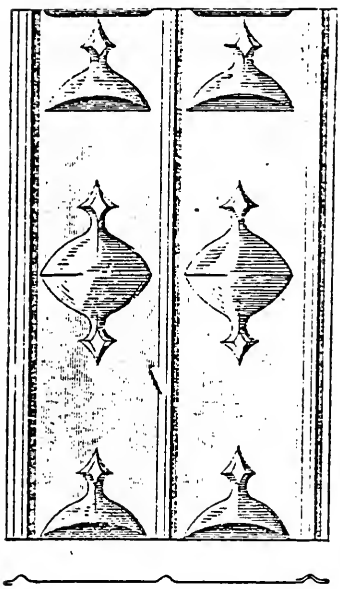


11.—*Method of Laying the Hyndman Shingles.*



Novelties.—Fig. 10.—Hyndman's Sheet-Metal Shingle, and Cleat for Fastening the Same.

FIGURE 33: Hyndman's Sheet Metal Shingle



Novelties.—Fig. 15.—New Metallic Shingles.—Detached Shingle.

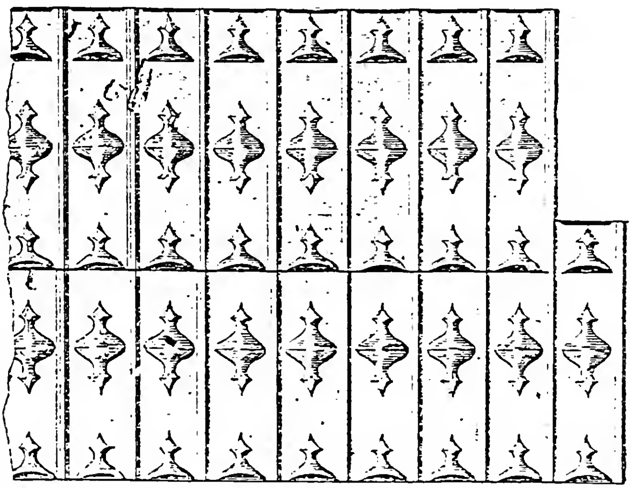


Fig. 16.—Portion of Roof Laid with the Anglo-American Co.'s New Shingle.

FIGURE 34: Anglo-American Roofing Company, Metallic Shingle

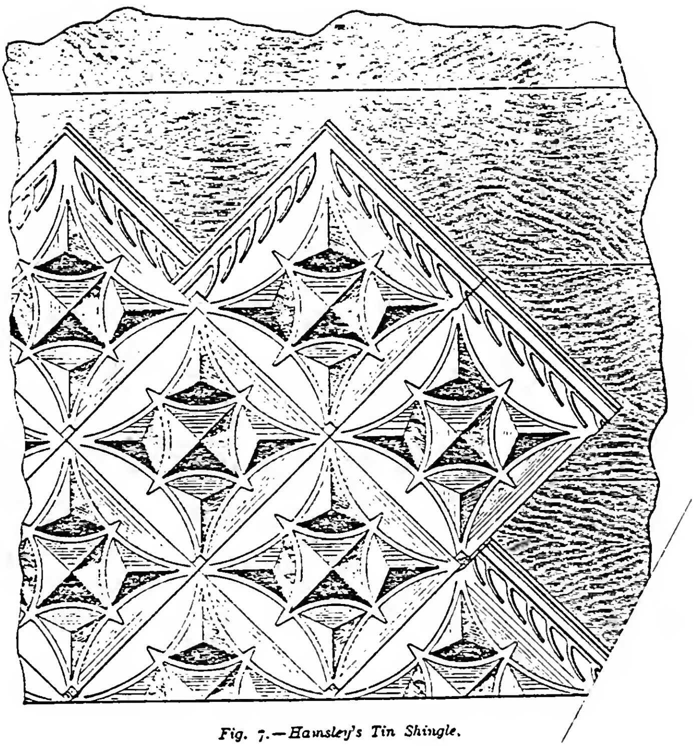
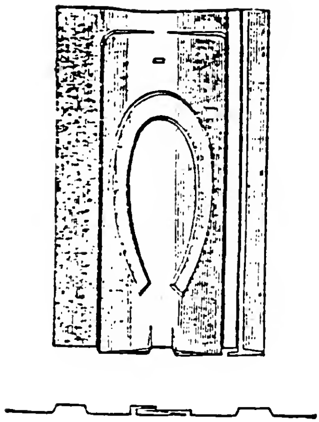


Fig. 7.—Hamsley's Tin Shingle.

FIGURE 35: George Cooper and Company, Hamsley's Shingle



Horseshoe Spring Lock Sheet Metal Shingle (Patten's Patent), made 7 x 10 and 10 x 14.

FIGURE 36: J.S. Thorn, Horseshoe Spring Lock Shingle

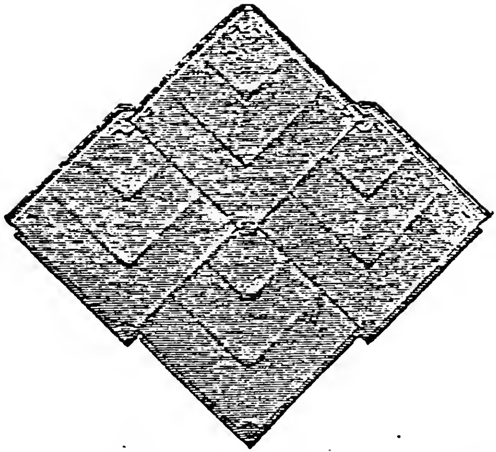


Fig. 2.—Group of Four Shield Pattern Tiles as combined in Laying.

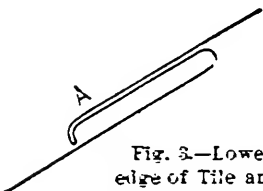


Fig. 3.—Lower edge of Tile and Nailing Flange.

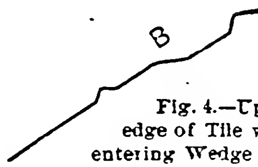


Fig. 4.—Upper edge of Tile with entering Wedge and Sunken Gutter.

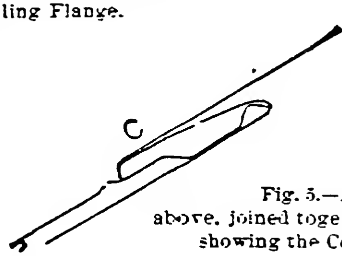
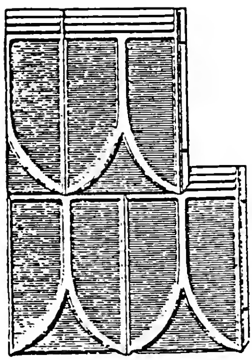
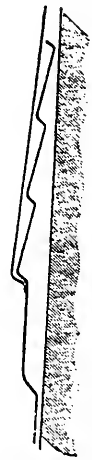


Fig. 5.—A and B as shown above, joined together as laid on roof showing the Covered Gutter.

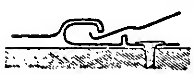
Figs. 3, 4 and 5.—Full size sections through edges of Shield Pattern Tile.

FIGURE 37: Cortright Metal Roofing Company, Diamond Shingles





9 and 10.—Group of Metal Slates as Combined in Laying, with full size section showing Joint at top and bottom of the Slate and raised Platform.



11.—Full size section of Side Lock, showing first position in laying.

12.—Full size section of Side Lock, showing the parts in place.

FIGURE 38: Cortright Metal Roofing Company, Metal Slates

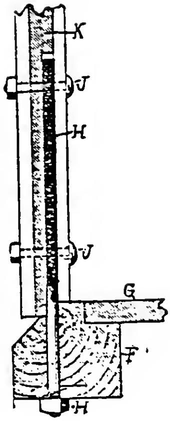


Fig. 12.—Sectional View Showing Construction of Sill and Fastening of Grooved Stud.

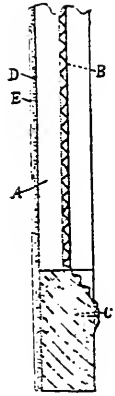
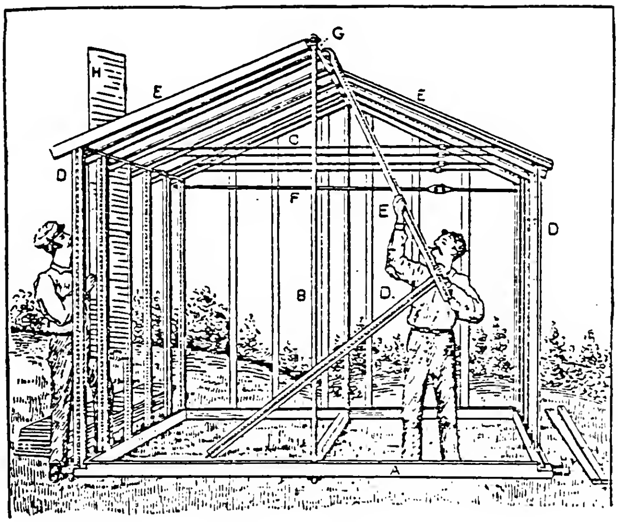


Fig. 13.—Showing Construction of Panels.



Novelties.—Fig. 11.—Showing Method of Framing Portable Iron Houses.

FIGURE 39: Iron Cottage Company, Method of Constructing and Framing Portable Iron Houses

FIGURE 40: Penn Iron Roofing and Corrugating Company, Advertisement for Products

VIRGINIA METAL SHINGLE ROOFING

FIRE PROOF—WEATHER PROOF—ORNAMENTAL

Made of Terne Plate Painted or Terne Plate Galvanized After Forming

MADE ONLY BY

WHEELING CORRUGATING CO., WHEELING, W. VA.

BRANCH OFFICES AND WAREHOUSES:

New York City, 47-51 Cliff Street
Chicago, 23, 25, 27 N. Clinton Street
St. Louis, 112, 114, 116 No. Eighth Street
Philadelphia, 402, 404, 406 Race Street
Boston, Mass., 132 and 134 Pearl Street
Chattanooga, Tennessee

Not Expensive

Write For Prices

Any Handy Mechanic Can Apply Our Metal Shingles

DIXIE, STELLA AND VIRGINIA ALL HAVE THE SAME SIDELOCK

The sidelock is perfect. Contraction and expansion is provided for. No solder is used.

The deep overlap makes a storm proof roof. Light in weight.

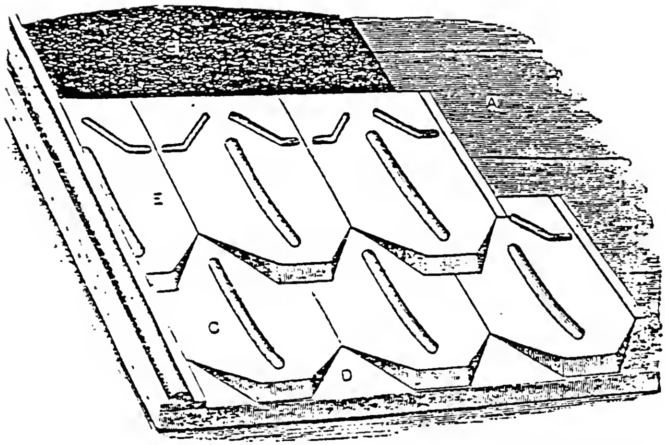
Our Metal Shingles are used in all parts of the country. Metal Shingles make a roof ornamental in appearance; a roof that will last indefinitely; a roof that will not leak; will not rattle; reduces the cost of insurance; requires no expert to lay.

They make a better roof than slate because they require lighter framing, will not break, and can be taken off and relaid on another roof without injury or waste.

Our shingles are made of the best quality full-weight roofing plates, carefully painted on both sides with the best iron oxide paint mixed with pure linseed oil. The color is dark red.

Galvanized shingles are galvanized after being formed, thereby leaving no raw edges.

FIGURE 41: Wheeling Corrugating Company,
Virginia Metal Shingles.



Section of Roof Covered with Thorn's Octagon Pattern Tile.

FIGURE 45: Thorn's Octagon Pattern Tile

ENDNOTES

PREFACE

1. Davenport, T.R.H. South Africa, A Modern History. p 126
2. Research conducted by Pilgrim's Rest Museum in South Africa has identified several American brandmarks on galvanised iron sheets.
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INTRODUCTION

1. Herbert, Gilbert. Pioneers of Prefabrication. p 116

A BRIEF HISTORY OF GALVAINISED IRON

1. 5000 Sheet Steel Products and Who Makes Them. p 6
2. Dickenson, H.W. "A Study of Galvanized and Corrugated Sheet Metal". Transaction of the Newcomen Society. vol 24, 1943-44. p 28
3. Giedion, Sigfried. Space Time and Architecture p 349
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    c. "New Braunfels - The Sheet Steel Town". Sheet Steel Service. vol 2, no 4, p 3
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